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Valuation of Environmental Impacts of Transportation Projects: The Challenge of Self-Interest Proximity

by

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ABSTRACT: Notable progress has been made in valuing non-monetary benefits of transportation projects such as travel time savings, but we are struggling to identify monetary values at the individual project level for many environmental attributes such as changes in open space, noise, air quality, greenhouse gas emissions and amenity. The difficulty may be aligned to the idea of attribute proximity to the self-interest paradigm. The empirical findings presented here, based on stated choice experiments, suggest that environmental attributes that are *distant* in self-interest proximity such as open space are unlikely to be appropriately valued when mixed in a trade-off with attributes *close* in self-interest proximity such as travel time or reductions in local traffic *unless* noticeable gains in self-interest attributes accompany desirable levels of attributes defining environmental impacts. This finding has important implications for the design of empirical studies using stated choice methods for valuation.

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Introduction

The project-based cost-benefit paradigm for urban transport infrastructure is dependent on the quantification of a heavily edited set of benefits such as travel time and operating costs. Although the environmental impacts of transport project investment are recognised as (positive or negative) benefits to be internalised, their consideration has been hampered by difficulties in establishing the monetary value of a unit of environmental impact. Economists have made substantial progress in valuing some of the non-monetary benefits such as travel time savings (although this remains controversial), but limited progress in valuing environmental attributes such as adjustments in open space, noise, air quality, greenhouse gas emissions and visual amenity. The difficulty may be closely aligned to the idea of attribute proximity to a self-interest paradigm.

Individuals in most modern economies are assumed to act as if they are self-interested utility maximisers, such that the relevance of attributes of transportation is highly dependent on their proximity to self-interest. The sociological literature suggests that this is a product of human behavioural ecology in which individuals have evolved to use resources in reproductively selfish ways. Heinen and Low (1992: 108), in a review of the evidence, conclude that

> …if benefits of conservation can be made to outweigh costs for people – for example through a system of economic or other incentives which confer immediate or very short-term benefits on individuals and/or their families and potential reciprocators – then effective conservation strategies are likely to persist and spread. If this is the case, governments and organizations may find it productive to implement policies that create systems of incentives to conserve: the more immediate the benefit, the more successful should be the outcome.

The ideas synthesised by Heinen and Low can be captured by the notion of proximity goals. Broad-based appeals to individuals to bear costs for a common good have had limited success; epitomising the challenge in valuation of attributes that are distant in self-interest proximity, in the presence of attributes that are close in self-interest proximity. Whereas user benefits such as travel time savings are likely to directly benefit the majority of individuals, many of the environmental benefits or costs of transport projects may not be closely aligned (at least perceptually) to the entire population (under a self-interest paradigm), and hence are often seen as of limited benefit to any subset of individuals in the population.

In seeking trade-offs between environmental attributes and user-specific attributes, the human behavioural ecology and evaluation literature suggests that individuals tend to discount the value of many environmental attributes because they are not willing to incur the costs now for benefits likely to accrue well into the future. This does not imply that individuals do not value benefits from environmental conservation, nor that some environmental impacts are not immediate, but that for many environmental attributes, the mixing of the environmental valuation paradigm with the self-interest valuation paradigm may not facilitate the revelation of such values. It depends on the specific environmental attributes and their self-interest proximity and immediacy impact on individuals. As has been often suggested for air pollution – if you cannot smell it or see it, it is simply not perceived as a problem; and the more distant some issue is away from immediate reproductive interests, the less it will pay to invest time, money and effort in its consideration (Colwell 1974).

To investigate this hypothesis and possible 'explanation' for the non-significance of more-distant environmental attributes when evaluated against more immediate impacting attributes, we designed a number of stated choice experiments incorporating mixtures of traditional user benefits and environmental attributes, and sought choice responses from individuals in two contexts: firstly, evaluation of a specific trip situation, and secondly, evaluation of a project as a whole. The results presented below, lead us to conclude that environmental attributes that are *distant* in self-interest proximity such as a loss of open space are indeed unlikely to be appropriately valued when mixed in a trade-off with attributes *close* in self-interest proximity such as travel time savings and reductions in traffic on local streets *unless* noticeable gains in self-interest attributes accompany desirable levels of attributes defining environmental impacts.

This finding, if replicated in other studies, suggests that for individuals to be able to evaluate and value many 'distant-impacting' environmental attributes, we either need to establish environmental valuations in contexts that do not involve trade-offs with any self-interest proximity user benefits; or mix them with self-interest attributes only where appropriate self-interest incentives are present. This is a controversial conclusion, but one that we hope will generate an alternative focus on the way that we seek out appropriate valuations of the fuller set of environmental attributes.

Stated choice experiments provide one framework within which to investigate the role of a wide range of environmental attributes, including potentially self-interesting environmental attributes, when mixed with traditional user benefits. We evaluate the appropriateness of mixing strongly self-interest attributes such as individual travel time savings, tolls and operating costs, with those environmental costs and benefits such as loss of open space and aggregate noise impacts that accrue at higher-than-individual levels.

Two variants on the treatment of traditional attributes are considered: one in which the use-related levels of traditional attributes such as travel time and tolls are mixed with the aggregate environmental attributes; and the other in which use-related attributes are aggregated for a project to be compatible, in an aggregated sense, with the aggregated environmental attributes. Four stated choice experiments, using a new road proposal in Sydney (the M5 East), provide the empirical context. The M5 East road could be built at ground level or in a tunnel, providing a trade-off between costs and environmental impacts. The relationship between the experiments is shown in Table 1.

Table 1 The alternative choice contexts for evaluating the role of environmental attributes

Attributes	**Choice question** **From community perspective:** Should the government build the M5 East or do nothing?	**From individual perspective:** Would you use the M5 East (if built) or your current route?
Traditional benefits only	Experiment 1	Experiment 3
Traditional user benefits AND environment/social impacts	Experiment 2	Experiment 4

The paper is organised as follows. Section 2 reviews transport project evaluation and the environment, valuation methods and the role of the stated choice method, and the self-interest debate in valuation. The empirical framework is presented in Section 3, including the case study site, the empirical strategy and design of the stated choice experiments. Empirical results are presented in Section 4, followed by key observations and conclusion in Section 5. This paper is not focussed on establishing suitable dollar values for environmental attributes, but rather on understanding a possible basis for why the valuation of many environmental attributes is so difficult.

Background

Transport project evaluation and the environment

The dominant form of project evaluation for handling competing benefits and costs is cost-benefit analysis (CBA). The traditional benefits from road transport projects are typically travel time savings, vehicle operating cost savings, and accident reductions, while project costs usually include land acquisition, construction and maintenance costs. The presence of transport infrastructure itself and the use of the infrastructure in urban areas often produce adverse environmental impacts. Although there are many studies on the *costs* of transport externalities as reviewed in Litman (1996), Maddison et al. (1996), and Murphy and Delucchi (1998), there has been limited research on the *valuation* of transportation externalities, especially environmental attributes, at the individual transport project level.

The environmental impacts of transport are extensive enough to justify their inclusion in project evaluation and decision-making. However, because they are difficult to monetise, they tend to be excluded; at best they are noted qualitatively as important. When Bateman et al. (1993) examined the application of CBA to trunk road assessment in the UK, they criticised the inadequate incorporation of environmental and non-market impacts within present appraisal practice. In support, Nash et al. (1990: 7) concluded that the "…existing procedure of computing a net present value which includes a monetary valuation of time and accident savings but excludes all environmental effects is seriously misleading". In Australia, the Victorian transport externalities study (EPA 1994) noted that the absence of a formal mechanism for incorporating uncosted impacts in the decision process meant these impacts were likely to be ignored and decisions made on the basis of perhaps accurate but partial, cost information.

Despite increasing use of community consultation, many transport infrastructure project evaluations reveal a lack of knowledge of community preferences, especially the trade-offs between transport and environmental impacts. For example, in the environmental impact statement for the M5 East proposal (Manidis Roberts 1994), there is no evidence of any determination of community preferences to support the conclusion reached that it was not justified to extend the length of the tunnel to reduce residential impacts, or to support other decisions such as the height of noise barriers, and the extent of the landscaping budget. Hopkinson et al. (1992: 98) note "…there is virtually nothing known about the relative weighting that people give to the travel benefits and various environmental benefits and disbenefits associated with a new road scheme". Several years on, little progress appears to have been made.

This may in part explain why, in mid-1998, the UK government introduced an Appraisal Summary Table (AST) approach in which the qualitative judgement of five assessment criteria is used alongside quantitative calculations where possible to determine the main economic, social and environmental impacts of road schemes. As the standard presentation of future proposals, it significantly downgrades the role of traditional CBA in scheme assessment. The five criteria are environmental impact including noise, air quality, landscape and heritage issues; safety; economy including journey time and vehicle operating costs, regeneration benefits and scheme costs; accessibility including public transport, severance and pedestrian issues; and integration. A seven-point scale, defined from a large negative to a large positive impact, is used where quantification is not available.

In the first application of the AST approach, a number of schemes with high benefit-cost ratios were dropped while others, ranked lower on economic evaluation, were approved (*Local Transport* 1998). For example, the M11 junction 5 north facing slip road improvement with a benefit-cost (B/C) ratio of 7.5 and the A4 Henlys/Waggoners corner improvement scheme with a B/C ratio of 25 were withdrawn from the roads program. In contrast, projects with B/C ratios between 1.5 and 1.9, such as the A6 Clapham-Bedford bypass, were approved.

Using stated choice methods to reveal the value of environmental gains and losses

The literature on alternative methods to place a monetary value on non-market goods is extensive (see Daniels 1994 for a review). One approach, stated choice methods, used in this paper, has a long history in transportation in the valuation of traditional user benefits such as travel time savings (see Hensher 1994 for a review). It is only recently, however, that stated choice methods have been used for environmental valuation, and most of these are natural resources applications. To date, the use of stated preference methods for environmental valuation (of which stated choice methods are one specific specification of a stated response) has been dominated by contingent valuation. Boxall et al. (1996) note that, in the environmental valuation field, there are relatively few examples of stated preference studies in which the stated response involves choosing from amongst a set of mutually exclusive alternatives, other than contingent valuation.

One of the first environmental applications of stated choice analysis was Adamowicz et al. (1994a) to evaluate recreational fishing quality for a water resource development project. Boxall et al. (1996) undertook a comparative study of stated choice and contingent valuation to investigate the effect of environmental quality changes arising from forest management practices on recreational moose hunting values. Opaluch et al. (1993) used a paired comparison approach to examine preferences for attributes of landfill sites in which respondents made a choice between a pair of landfill sites, described in terms of either site or location characteristics. Adapted from contingent valuation, it was called contingent choice. Adamowicz et al. (1994b) cite several studies which have used stated preference ranking or rating techniques, rather than choice, for environmental valuation.

The interest in stated choice experiments to value environmental attributes is growing. For instance, recent and current applications of stated choice in Australia include identifying preferences for the preservation of rainforests (Rolfe and Bennett (1996b), identifying community preferences for future water supply options and associated environmental benefits in the ACT (Centre for International Economics 1997), valuation of the Macquarie Marshes and Gwydir Wetlands in north-western NSW (Morrison et al. 1998), and the value of remnant vegetation in the desert uplands of central Queensland (Blamey et al. 1997).

Despite the uses of stated choice experiments in transport and environmental valuation (separately), there have been few applications of the technique for valuation of the environmental aspects of transport. Nash et al. (1991) noted that stated choice methods have not been used in this context, although it is a promising application. Adamowicz (1996) notes that examples of passive use value measurement in a transportation case are scarce; but in terms of transport externalities, passive use values may be associated with changes in environmental quality (air or water) that affect an ecosystem, and loss of habitat perhaps threatening endangered species.

Two recent examples of the use of stated choice analysis for valuation of environmental amenity related to transport are a study of air pollution in Norway by Sælensminde (1995) and work on transport, urban form and environmental tradeoffs in Calgary by Hunt Analytics (1994). Sælensminde (1995) estimated people’s willingness to pay to reduce local air pollution caused by road traffic in the form of emissions of dangerous exhaust gases, noise, dust/dirt from road wear and CO_2 emissions. The choice experiments were simple with two alternatives and four attributes each, designed to test the application of the method. Respondents were offered choices between the environmental consequences of using future types of tyres and fuel, and future transport policies. Each of the five experiments involved a choice between two alternative journeys (either two bus journeys, or two car journeys) with four attributes: transport cost and time plus two environmental attributes, either noise and local air pollution, or dust/dirt and CO_2. While the paper explains the stated choice method used, the derivation of the results including details of the models used or statistical significance of the reported valuations is not presented or discussed.

Hunt Analytics (1994) and Hunt et al. (1995) undertook a stated preference analysis for the City of Calgary in Canada that measured trade-offs between mobility, built form, environment, and costs and taxes including road tolls. 961 households *ranked* three sets of four hypothetical alternatives, with each alternative described along the lines of: "…a new situation for your household 1 or 2 years from now. The new situation includes a new home location in the City and may also include new work locations for employed household members." Attributes representing mobility were travel time to work by auto and public transport; attributes for built form were housing type ranging from single family, in-fill, duplex, townhouse, medium density and high rise; environment attributes were frequency of noticeably bad air quality, proximity to a river valley or an "environmentally significant area" (either near or far), and road development through the river valley or environmentally significant area (present or absent); and attributes representing costs and taxes were money cost of the auto trip to work excluding parking, public transport fare and municipal taxes.

In the Calgary study, environmental values and trade-offs were reported relative to reductions in auto trip time or municipal taxes. For instance, the benefit of living near to, rather than far from, an environmentally significant area was equivalent to a reduction in auto travel time of 24 minutes per trip, or equal to a reduction in municipal taxes of approximately $C61 per month (Hunt Analytics 1994: 29-30). Utility functions were developed to evaluate the total change in utility arising from changes in individual attributes. The change in utility could be expressed in dollar equivalents, thereby assisting cost-benefit analysis for policy evaluation.

The significance of the study is its use of stated preference experiments to investigate trade-offs between transport, urban form and the environment, in which the results suggested that the respondents behaved realistically in the hypothetical situations presented in interviews. The calculated trade-off rates were consistent with what is known about the trade-off behaviour of Calgarians from previous work using observations of actual rather than hypothetical choice behaviour (Hunt Analytics 1994: 10). In addition, the variations in rates for different sub-samples were consistent with expectations.

A study for the Wellington Regional Council in New Zealand on the community's social wants from the region's transport system by McDermott Miller (1997) recognised that transport decisions must be made to reflect the broader social need, not just individuals' own narrow self-interest. Surveys using adaptive conjoint analysis were undertaken to rank and value the community's preferences for a range of social benefits. Although the study was concerned with both individual and collective social benefits, respondents did not assess personal benefits in the same context as societal outcomes such as social equity or environmental disruption. The report does not contain any model results, parameters or statistical significance results. An example of the interpretation of results is that the average person is prepared to pay a premium of NZ$0.40 a week for transport improvements which save 30 minutes travel a week if these improvements are achieved with no, rather than minor, social disruption.

Social or self-interest perspectives in valuation?

An important assumption in s*ocial* cost-benefit analysis is the use of individual-based values. However, individuals may not always respond to valuation questions from an individual perspective. The extent to which individuals may respond to stated choice experiments from a social or citizen perspective, potentially confusing the Hicksian aggregation assumption in establishing total societal benefit, is a significant issue.

A number of terms have been used to express the dichotomy of valuation perspectives such as Sagoff's (1988) consumer-citizen conflict, which is discussed here. Other definitions have been used to represent the consumer-citizen conflict. For instance, Blamey and Common (1993) refer to private and social agents. In a similar vein, Edwards (1992) has raised the issue of different perspectives on valuation by defining the existence of egoists and altruists among respondents while Hopkinson et al. (1992) note that people are capable of viewing an issue from both a selfish and a social perspective.

The extent to which people respond to valuation questions as *consumers*, concerned only about self-interest, rather than as *citizens*, concerned for the public interest and community good is an important issue, often raised as a possible source of correlated confoundment in the aggregation of individual values. Sagoff (1988) believes that people possess incompatible consumer and citizen preference orderings and that 'economic man' and the citizen are for all intents and purposes two different individuals. Sagoff (1988) has suggested that people may behave, in different contexts, as either consumers or citizens which has implications for valuation in CBA. Sagoff (1988: 8) explains the concepts as follows:

> As a citizen, I am concerned with the public interest, rather than my own interest; with the good of the community rather than simply the well-being of my family. As a consumer, I concern myself with personal or self-regarding wants and interests; I pursue the goals I have as an individual. I put aside the community-regarding values that I take seriously as a citizen, and I look out for Number One instead.

Sagoff (1988: 27) explains that "as consumers, we act to acquire what we want for ourselves individually, each of us follows his or her conception of the good life. As citizens, however, we may deliberate over and then seek to achieve together a conception of the good society". So if there are two perspectives for response to valuation, how (dis)similar are they? And can they both be revealed through the same specification of the attribute set in a choice design?

The implications of consumer or citizen responses to valuation questions have been raised by Blamey and Common (1993) who note that the consumer-citizen conflict has implications for the theoretical soundness of cost-benefit analysis, as consumer responses (rather than citizen responses) are needed for valuation results to be used in CBA. If respondents behave as citizens and take into account benefits to others as well as themselves, aggregate benefit measures may involve under-counting or double-counting. Sagoff (1988) argues that in making hard decisions, which includes decisions about the environment, individuals act as citizens rather than as consumers.

Although discussed in the context of contingent valuation (CV), the debate is equally relevant to the use of stated choice for valuation. Blamey et al. (1995) question the traditional assumption that responses to contingent valuation questions may be interpreted as expressions of consumer preferences. They believe that increasing use of dichotomous choice elicitation procedures and public policy instruments such as taxes as payment vehicles raises the possibility that respondents in contingent valuation surveys may be expressing social or political judgments rather than preferences over consumption bundles. Respondents replying as citizens may incorporate into their replies citizen assessments of implications for jobs or other economic costs of preservation. If contingent valuation studies are understood as referendum surrogates, citizen responses are not an issue.

In a study of forest preservation in south-east Australia, reported variously by the Resource Assessment Commission (RAC) (1992), Carter (1992) and Blamey and Common (1993), Blamey et al. (1995) report evidence supporting the interpretation that respondents are acting primarily as citizens. Although the interpretation was based on a dichotomous choice, referendum contingent valuation study, the consumer-citizen implications are relevant to other types of valuation methods, particularly stated choice studies.

Reanalysing the dataset, Blamey et al. (1995) found that both consumer and citizen motivations appear to be involved in the contingent valuation responses, with citizen considerations being more important in terms of explaining the responses (agreeing to forest preservation scenarios at varying costs) than consumer considerations (Blamey and Common 1993). The probability of accepting forest preservation scenarios was relatively unresponsiveness to consumer variables (such as the price of preserving forest) compared with citizen variables (such as the need to do more to protect the environment, or agreeing we currently have a reasonable balance). In fact Blamey et al. (1995) found that the response to a single citizen question (that Australia needs to concentrate more on protecting the environment) provided much the same predictive power as the full multinomial logit model. Blamey et al. (1995: 285) concluded that “the evidence from this study suggests that responses to CV questions concerning environmental preservation are dominated by citizen judgments concerning desirable social goals rather than by consumer preferences”.

Blamey et al.’s citizen interpretation of the forest preservation responses has been challenged by Rolfe and Bennett (1996) on several fronts. Rolfe and Bennett argue that “ethical concerns” do not make people’s preferences special because ethical concerns impact on most preferences formed and because the impact of ethical concerns varies. Rolfe and Bennett also argue that individuals taking into account the benefits of others as well as themselves is not double-counting. They claim Blamey et al. ignore the incentives that explain why people make different choices in different settings (such as a direct willingness to pay question vs a referendum style dichotomous choice question), arguing that alternative incentives explain behavioural differences between market transactions and

referendum votes. Rolfe and Bennett also argue that attitudinal variables used to represent citizen responses in the willingness to pay model are not independent, because they are essentially expressions of the same factors that determine willingness to pay.
In another natural resource valuation context, Carson et al.'s (1990) study of demand for Kenai King salmon provided some evidence that sports fishers had a citizen perspective. Results indicated that "sports fishers have a sense of fair or appropriate harvesting levels tied to a notion of preserving the fishery, and they disapprove of permits beyond these levels, even for themselves" and suggested that fishers "are considering issues of fairness and the possible deleterious externalities of overharvesting in their valuations".

This review highlights a number of important issues. In particular, it is unclear whether individuals, when evaluating alternative attribute mixes involving environmental attributes that have public good characterisation with benefits accruing well into the future, evaluate them in terms of self-interest or good citizenry. The answer may lay in the specification of the set of attributes and the nature of the choice response. Our reading of the literature suggests that there is real potential for confusion within an experiment between evaluation of choices for self-interest in contrast to social esteem.

The review also suggests that it is quite possible that an environmental attribute that is distant in proximity in term of consumer self-interest (as revealed in experiment 4 - see Table 1) and statistically not significant in a user choice, may become closer in proximity in terms of *citizen-interest* (as revealed in experiment 2) and statistically significant in a citizen choice. Consequently a significant valuation of an environmental attribute derived from the latter context may indeed be misleading as the basis for valuation in project appraisal. The inability to establish a statistically significant environmental attribute in a consumer experiment is no basis for cross-referencing to a citizen model for a significant result; rather we prefer to raise the concern about mixing attributes in a consumer model that have notable differences in proximity to self-interest. Another way of saying this is that *if all attributes in a consumer choice experiment are within a bounded space of similar proximity to self-interest then meaningful valuations will be revealed. Environmental attributes are as much contenders as other attributes*. Table 2 summarises the range of terminology used in the literature to capture the two main evaluation perspectives.

Table 2 Alternative and potentially conflicting perspectives in valuation responses

Source	**Individual**	**Non-Individual**
Sagoff (1988)	Consumer	Citizen
Blamey and Common (1993)	Private agents	Social agents
Edwards (1992)	Egoists	Altruists
Hopkinson et al. (1992)	Selfish perspective	Social perspective
Daniels and Hensher herein	Use	Community
Daniels and Hensher herein	Self-interest	Aggregate

The empirical study presented in the next section provides one approach to understanding self-interest proximity in the context of urban transport. We suggest that environmental attributes that are *distant* in self-interest proximity, such as aggregate open space impacts, are unlikely to be appropriately valued by an individual when mixed in a trade-off with attributes *closer* in self-interest proximity, such as travel time, *unless* noticeable gains in self-interest attributes accompany desirable levels of attributes defining environmental impacts.

Empirical framework

Empirical strategy

Four attribute trade-off experiments were developed in the context of a 1994 proposal to build the M5 East, a 13 km extension of the existing M5 tolled motorway in the southern precincts of Sydney. The relationship between the four trade-off strategies was shown in Table 1. The experimental design strategy included two experiments for building the M5 East from a community perspective, and two experiments about using the M5 East if built from a user perspective. The first experiment in each set contained the traditional benefits of new roads and funding variables, while the second experiment in each set contained an expanded set of attributes including the traditional benefits and funding attributes, as well as environmental impacts.

Community perspective experiments

In the first set of experiments (Experiments 1 and 2), respondents were asked the choice question: “based on the costs and benefits in this description, do you think the government should build the M5 East or not?” The description in Experiment 1 contained the traditional benefits of road projects expressed at an aggregate, “community-benefit” level, rather than at an individual or personal level. In Experiment 2, an expanded set of attributes was given with environmental impacts added to the description.

Respondents were asked to decide what is best from a community point of view. The extent to which some respondents may have answered from a selfish perspective can be tested in subsequent analysis through the significance of attributes reflecting personal benefit. Before the stated choice experiment was conducted, respondents were given information about the project and shown a map of the region with the proposed route marked.

Use perspective experiments

In the second set of experiments (Experiments 3 and 4), respondents were asked the choice question: “based on the costs and benefits in this description, would you use the M5 East or your current route?” for a trip like their most recent journey. Experiment 3 contained only the traditional project benefits at the individual level, reflecting the “traditional” stated choice experiment used to estimate value of travel time savings, the most common and long-established use of stated choice methods in transport. Experiment 4 contained an expanded set of attributes: the traditional benefits at the individual level, as well as environmental and social impacts.

The choice question in the second set of experiments was a personal use question, asking about individual behaviour in the context of a journey made recently. The "most recent trip" was defined as a one-way car trip (as the driver) of at least 20 minutes in the area shaded on a map shown to respondents. Only those respondents who had made a car trip as the driver within a specified area in the last 2-3 months answered the second set of experiments. The map had a corridor shaded around the M5 East which included the major roads from which the M5 East would draw drivers.

In each of the four experiments, respondents were given descriptions of pairs of transport alternatives, either:

- the current network or route vs the M5 East at ground level, or
- the current network or route vs the M5 East in a tunnel,

and asked to make a choice based on their trade-offs between the costs and benefits of the proposed project (either at ground level or in a tunnel) compared to the current situation. In each binary choice, one alternative was fixed each time (the current network or route), while the other alternative varied, either the M5 East at ground level or the M5 East in a tunnel.

Attributes and levels

The choice experiments were designed to investigate the trade-offs between the costs and benefits of the proposed project. Tables 3 (a – d) summarise the attributes and levels in each experiment. The attributes were classified under three headings: traditional benefits, funding attributes and environmental/social impacts.

Table 3a Attributes and levels for Community Experiment 1

Description	Levels
Travel time spent by all vehicles travelling on roads in the area	C: 90 mill hrs M5: 80, 70, 60 mill hrs
Total vehicle running costs of all motorists travelling in the area	C: $450 m pa M5: $425, $400, $375 m pa
Serious accidents per year	C: 220 M5: 170, 120, 70
Owner of road	C: government M5: 0=private, 1=government
Construction cost	C: na M5 grd: $450, $400, $350 m M5 tun: $750, $650, $550 m
Funding arrangements	C: na M5: 0=users pay tolls 1=users pay half/community pays half 2=community pays full cost
Type of road/project structure	C: na M5: 0=tunnel, 1=ground

Notes for Tables 3a-d:
C = Current network/route; M5 = M5 East
Na = not applicable; M5 grd = M5 East at ground level; M5 tun = M5 East in tunnel

Table 3b Attributes and levels for Community Experiment 2

Description	Levels
Travel time spent by all vehicles travelling on roads in the area	C: 90 mill hrs M5: 80, 70, 60 mill hrs
Total vehicle running costs of all motorists travelling in the area	C: $450 m pa M5: $425, $400, $375 m pa
Serious accidents per year	C: 220 M5: 170, 120, 70
Houses moderately to highly affected by traffic noise in the region	C: 4000 M5: 3500, 3250, 3000
Houses moderately to highly affected by traffic noise near the new road	C: na M5 grd: 300, 200, 100 M5 tun: 0
Bushland lost: football field equivalents	C: na M5 grd: 200, 150, 100 M5 tun: negligible
Open space lost: football field equivalents	C: na M5 grd: 30, 20, 10 M5 tun: negligible
Traffic on local streets (% less traffic)	C: na M5: 40%, 25%, 10%
Visibility of the road	C: na M5 grd: 0=ground level 1=partly elevated 2=elevated on pylons M5 tun: not visible
Owner of road	C: government M5: 0=private, 1=government
Construction cost	C: na M5 grd: $450, $400, $350 m M5 tun: $750, $650, $550 m
Funding arrangements	C: na M5: 0=users pay tolls 1=users pay half/community pays half 2=community pays full cost
Sydney households pay increased rates of $x a year for 2 years to cover extra cost of tunnel (only included if Type of road=0)	C: na M5 grd: na M5 tun: $50, $35, $20
Type of road	C: na M5: 0=tunnel, 1=ground

Table 3c Attributes and levels for Use Experiment 3

Description	Levels
Trip length: length of your trip in minutes	C: 30 mins (60) M5: 25, 20, 15 mins (50, 40, 30)
Running costs: costs of running your vehicle for your trip such as petrol and wear and tear	C: $1.10 ($2.20) M5: 90, 70, 50 cents ($1.80, $1.40, $1)
Toll for one-way trip	C: na M5: $3, $2, $1
Type of road/project structure	C: na M5: 0=tunnel, 1=ground

Note: Figures in brackets represent levels for Long set of showcards

Table 3d Attributes and levels for Use Experiment 4

Description	Levels
Trip length: length of your trip in minutes	C: 30 mins (60) M5: 25, 20, 15 mins (50, 40, 30)
Running costs: costs of running your vehicle for your trip such as petrol and wear and tear	C: $1.10 ($2.20) M5: 90, 70, 50 cents ($1.80, $1.40, $1)
Houses moderately to highly affected by traffic noise in the region	C: 4000 M5: 3500, 3250, 3000
Houses moderately to highly affected by traffic noise near the new road	C: na M5 grd: 300, 200, 100 M5 tun: 0
Bushland lost: football field equivalents	C: na M5 grd: 200, 150, 100 M5 tun: negligible
Open space lost: football field equivalents	C: 0 M5 grd: 30, 20, 10 M5 tun: negligible
Traffic on local streets (% less traffic)	C: 0 M5: 40%, 25%, 10%
Visibility of the road	C: na M5 grd: 0=ground level 1=partly elevated 2=elevated on pylons M5 tun: not visible
Owner of road	C: government M5: 0=private, 1=government
Construction cost	C: na M5 grd: $450, $400, $350 m M5 tun: $750, $650, $550 m
Funding arrangements	C: na M5: 0=users pay tolls 1=users pay half/community pays half 2=community pays full cost
Sydney households pay increased rates of $x a year for 2 years to cover extra cost of tunnel (only included if Type of road=0)	C: na M5 grd: na M5 tun: $50, $35, $20
Toll for one-way trip	C: na M5: $3, $2, $1
Type of road	C: na M5: 0=tunnel, 1=ground

Note: Figures in brackets represent levels for Long set of showcards

Traditional user benefits

The traditional benefits of major urban road projects are travel time savings, operating cost savings and accident reductions. The economic evaluation of the M5 East (Applied Economics 1994) showed total benefits of just over $1,000 million, of which 77% were due to travel time savings, 21% were vehicle operating cost savings and less than 2% were from accident reductions.

At the aggregate level, travel time savings were expressed as the total time spent by all vehicles travelling on roads in the area per year (on either the current road network or the network with the M5 East built), while at the individual level travel time was trip length in minutes (on the current route or the M5 East). Although it is difficult to define the relevant network in the area, the traffic analysis included in the EIS was used as a base. At the aggregate level, operating cost savings were defined as total vehicle running costs of all motorists travelling in the area, and at the individual trip level as costs of running your vehicle for your trip such as petrol and wear and tear. Accident reductions were described as serious accidents per year on the current road network and on the network if the M5 East was built. Reduction in accidents was not included in the individual level, trip-based experiments due to difficulties in expressing the level of risk for one trip, and the difference in risk between the current route and the M5 East for a single trip.

Environmental impacts

The Environmental Impact Statement for the M5 East (Manidis Roberts 1994) discussed many environmental impacts, which could not all be included in the stated choice experiments as environmental costs. While some research indicates respondents can evaluate large numbers of attributes, most researchers suggest a limited number of attributes is more reasonable for respondents. For instance, using six case studies that examine choice within very different product classes, Swait and Adamowicz (1996) found that task complexity significantly affects the variance of choice in a fashion that is consistent with notions of limited consumer processing capacity and cognitive budgets.

Determining the extent of information given in hypothetical market studies such as the number of attributes to include in the stated choice design is a careful balance between completeness for the sake of the research and producing a fair and reasonable task for the respondents. Striking a balance between the amount of information provided and the simplicity and conciseness required for respondents to understand and assimilate information in contingent valuation surveys (Bennett and Carter 1993) is equally applicable to stated choice surveys.

With an awareness of these issues, the subset of environmental impacts selected for inclusion in the study were: noise, loss of bushland, loss of open space, visual impact, and reduction in traffic on local streets. Although building the M5 East would reduce traffic noise in the region by taking traffic off local roads, it would also increase traffic noise for people not currently affected by traffic noise. It was important to acknowledge this distinction. Thus the experiments included two attributes to represent noise: number of households moderately to highly affected by traffic noise *in the region*, and number of households moderately to highly affected by traffic noise *near the proposed road*. This measurement of noise impact was defined in a specialist working paper on noise by Renzo Tonin, cited in Applied Economics (1994).

In terms of impacts on green space, a distinction was made between bushland and open space. Bushland lost by the construction of the road was expressed in “football field equivalents” rather than hectares, to provide a more meaningful unit of measurement to respondents. In a review of responses from community consultation on the initial M5 East proposal for a ground-level road through urban bushland, Brewer and Ross (1996) note that bushland was the most important issue of concern raised. Open space lost was also expressed in "football field equivalents". The EIS noted that there is an overall shortage of open space for sporting purposes in the surrounding area (Manidis Roberts 1994). Elevation of the ground level road project was also included. A road elevated on pylons would have less environmental impact, but would have a more severe impact on visual amenity. To compensate for the environmental impacts of the project, an environmental benefit was included: reduction in traffic on local streets.

Although air pollution through its consequent impacts on health is considered to be one of the most damaging aspects of vehicle use, it was not included as an attribute because air quality is a metropolitan wide problem across the Sydney basin, and it was difficult to identify the impact of the M5 East, as a single project, on air quality at the local level.

Funding attributes

There is a considerable body of evidence from contingent valuation applications of a wide range of non-market goods which demonstrates the great importance of the payment mechanism, that is the means by which individuals or the community are asked to express their preferences in a monetary sense, such as increases in utility bills, park entry fees, local property or sales taxes, or donations to special funds. Thus funding attributes were carefully specified.

Funding attributes included ownership of the project (public or private), source of funds for construction (by tolls, through general revenue, or a combination), construction cost of the project, and a household levy to pay for the increased cost of the tunnel. Construction cost was lower for the ground level option than for the tunnel, with the highest level of construction cost for ground ($450 million) lower than the lowest construction cost for tunnel ($550 million).

Three sources of funding were devised for the project: the project could be funded by the government from existing funds; funded by a toll on users of the new road; or a combination (half from existing funds and half from a toll). Hensher and Battellino's (1997) study of community preference for traffic control devices included allocation of community resources, represented by the cost of the traffic control devices and the source of funds at three levels: Council, State Government, and rates increase.

For the tunnel option that has a higher construction cost, the community contributed to the extra cost through a household levy, defined as an increase in rates. The household levy through an increase in council rates was chosen because it is a method which applies to all households, whether users or non-users of the M5 East. While road users would pay through the toll, unless non-users personally incur a financial cost such as through a household levy, there is no incentive for them to make trade-offs between the costs and benefits of the project. Non-users would always choose the most expensive, environmentally friendly option to express their preference for the environmental benefits of the tunnel because they are not bearing any of the cost.

A levy on property rates is not a common method for funding infrastructure development or public policy programs in Australia. However there is a precedent for a household based levy for environmental purposes. In 1989, the Sydney Water Board instigated a Special Environmental Levy of $80 per customer per year for five years to fund projects to improve water quality and other related environmental projects.

The M5 East EIS was used as a base to select levels to establish internal consistency within the experiments. The levels for some attributes such as construction cost and some environmental impacts varied by ground or tunnel option, while for other attributes, the same levels were used for both the ground and tunnel options.

Experimental design

The basic design was a binary choice between the current road network and the M5 East. However the M5 East had two options: either at ground level, with greater environmental impacts but a lower construction cost, or in a tunnel with reduced environmental impact but at a higher construction cost. To incorporate this into the design, a two level attribute representing project structure was added to the experiment. If the design generated a profile with a "ground" level for the project structure attribute, then all other attributes for the M5 East option took the levels corresponding to the ground level option, while if the design generated a profile with the level of "tunnel" for project structure, then all other attributes took the levels corresponding to the tunnel option. Construction costs were higher for the tunnel: the lowest tunnel cost was higher than the highest ground level cost. For the tunnel option, there was no traffic noise near the road, no bushland lost, no open space lost and for visibility of the road, it was not visible.

To reduce the total number of profiles associated with each of the four experiments to a manageable set of profiles, a fractional factorial design was generated. All fractions were orthogonal attributes for a main effects plan with no independent two-way interactions. See Daniels (1997) for details. To enrich the analysis of preferences and develop greater understanding of choices and responses, the survey also included questions on contextual attributes including attitudes to transport and the environment, environmental concern, funding issues, knowledge of the project, transport and travel characteristics, and socio-demographics. Discussion of some contextual responses is provided in Daniels (1996).

Survey implementation

The survey was administered face-to-face to 150 respondents in their homes in early 1996. Respondents were sampled from four areas in the vicinity of the M5 East chosen to represent different combinations of likely personal impact and benefit from the road proposal. Of those people who were eligible to be interviewed, the response rate was 39%, not unusual for a survey with an average length of 45 minutes. The survey introduction did not mention the M5 East.

Each of the four experiments was replicated three times, to provide 450 observations each for Experiments 1 and 2. Over three-quarters of the respondents (76%) had made a trip in the area recently, providing 340 observations each for Experiments 3 and 4.

There were twice as many choices in support of building the M5 East in community experiments 1 and 2 (72%, 64%) as there were choices for using the M5 East in the use experiments 3 and 4 (31%, 34%), as shown in Tables 4 and 5. Although people did not choose to use the M5 East themselves for a trip like their most recent trip, they still supported its construction. For Experiments 1 and 2 combined (six choices), almost 60% of respondents always made the same choice (45% always chose the M5 East option, and 14% always chose do nothing), while for Experiments 3 and 4 combined, 48% always made the same choice (6% always for the M5 East, and 42% always for their current route).

Table 4 Community Experiments 1 and 2: Consistency and variability in choice

Option chosen	Build the M5 East or do nothing?		
	Experiment 1 Trad. attributes	**Experiment 2** Trad. + env. attributes	**Exps 1 & 2** (6 choices)
Total choices	450	450	
% of choices for "build the M5 East"	72%	64%	
% of choices for "do nothing" option	28%	36%	
Total respondents	150	150	150
Chose M5 East option 3 out of 3	60%	50%	45%
Chose do nothing option 3 out of 3	19%	21%	14%
Respondents whose choice varied	21%	29%	41%

Table 5 Use Experiments 3 and 4: Consistency and variability in choice

Option chosen	Use the M5 East or current route?			
	Experiment 3 Trad. attributes	**Experiment 4** Trad. + env. attributes	**Exps 3 & 4** (6 choices)	**Exps 1-4** (12 choices)
Total choices	342	340		
% of choices for M5 East	31%	34%		
% of choices for current route	69%	66%		
Total respondents	114	114	114	114
Chose M5 East option 3 out of 3	14%	12%	6%	4%
Chose current route 3 out of 3	53%	47%	42%	9%
Respondents whose choice varied	33%	40%	52%	87%

'Self-interest' Proximity Evaluation of a Proposed Road

Estimation Approach

Four model specifications were estimated for each of the four stated choice experiments:

1. The multinomial logit (MNL) model in which all choice replications are assumed to be independent, obtained by maximum-likelihood estimation,
2. A probit model estimated by simulated maximum likelihood (SML) with allowance for serial correlation across the choice replications for each individual,
3. A probit model estimated by SML, incorporating unobserved heterogeneity or random effects associated with each alternative, to pick up differences in individual idiosyncracies not accommodated by the set of observed explanatory variables, and
4. A probit model estimated by SML, combining correction for serial correlation and unobserved heterogeneity.

The generalised utility expression can be written as equation (1).

$$u_{jqt}=X_{jqt}\alpha + y_{qt}\beta_j + \varepsilon_{jqt} \qquad (1)$$

where

u_{jqt} is latent *utility* of alternative j as perceived by individual q in choice replication t
X_{jqt} is alternative-specific *attributes* of alternative j as perceived by individual q in choice replication t
y_{qt} is individual-specific *characteristics* of individual q in choice replication t
ε_{jqt} is multinormal error with $cov(e_q)=\Omega$ ($e_q = (e_{jqt})_{j=1...I,\ t=1...T}i$) for all SML models and EV type 1 for MNL.

where

Ω is $I\times T_i$, permitting inter-alternative and inter-replication correlation between e_{jqt} and e_{kqs} for the same individual q, and
α, β_j, and Ω are parameters to be estimated

The models are described by a likelihood function which is a product of the choice probabilities (equation 2) across the sample of q=1,...,Q individuals, i=1,...,I alternatives and t=1,....,T stated choice replications.

$$L(b,M)=\prod_{q=1}^{Q} P(\{i_{tq}\}\,|\,\{X_{itq}\};b,M \qquad (2)$$

The cumulative distribution function, characterised by the covariance matrix *M*, is assumed to be extreme value type 1 for the base MNL model, and multivariate normal for the other three models. When we move beyond the simple MNL model, estimating the parameters becomes more complex. Simulation of the choice probabilities is the preferred method of estimating all parameters, by drawing pseudo-random realisations from the underlying error process (Boersch-Supan and Hajivassiliou 1990).

The method was introduced by Geweke and improved by Keane, McFadden, Boersch-Supan and Hajivassiliou (see Geweke et al. 1994, McFadden and Ruud 1994). It involves computing random variates from a multivariate truncated normal distribution. Although it fails to deliver unbiased multivariate truncated normal variates (as initially suggested by Ruud and detailed by Boersch-Supan and Hajivassiliou 1990), it does produce unbiased estimates of the choice probabilities. The approach is quick, and the generated draws and simulated probabilities depend continuously on the parameters β and M. This latter dependence enables the use of conventional numerical methods such as quadratic hillclimbing to solve the first order conditions for maximising the simulated likelihood function (equation 3)-hence the term simulated maximum likelihood (Stern 1997).

$$\bar{L}(b, M) = \prod_{r=1}^{R} \prod_{q=1}^{Q} \bar{P}_r(\{i_q\}) \qquad (3)$$

Boersch-Supan and Hajivassiliou (1990) have shown that the choice probabilities are well approximated by the formula (4), even for a small number of replications. Our experience suggests that 100 replications (R=100) is sufficient for a typical problem involving up to 5 alternatives, 1000 observations and up to 10 attributes. With currently available desktop computers, such calculations should converge in less than 5 minutes. All models except the MNL model were estimated using SML with 100 replications in the simulation estimator.

$$\bar{P}(\{i_q\}) = \frac{1}{R}\sum_{r=1}^{R} \bar{P}_r(\{i_{qn}\}) \qquad (4)$$

Empirical Results

The four stated choice experiments provide the empirical framework within which to explore the role of environmental attributes in a 'use' (Tables 6a-d) and a 'community' (Tables 7a-d) evaluation of a proposed new (toll) road, the M5 East.

Each individual evaluated one specification of the M5 East proposal (ie ground or tunnel) at a time. In estimating the series of model specifications for each choice experiment, we investigated separate models for ground vs current and tunnel vs current and a combined model for the sample of current vs ground vs tunnel. However they did not add any further insights to results from the redefined binary choice model when the ground and tunnel options were collapsed into one alternative. A dummy variable was introduced to establish any possible differences in the tunnel vs ground options, after controlling for design attributes. It was never found to be statistically significant (Tables 6b, 7a and 7b).

The 'Self-Interest' Use Models

The minimal 'use' or 'self-interest' model, based on Experiment 3, has two design attributes and a number of contextual variables, as summarised in Tables 6a and 6b. The user-specific attributes, travel time and toll, are statistically significant across all four specifications; and remain significant when we introduce a number of covariates in Table 6b to represent elements of environmental segmentation. Table 6b suggests that females, individuals who rank the environment highest priority for government spending, and those who donate time and money to environmental causes, have a higher probability of rejecting the M5 East option. In contrast, individuals who were visiting friends and relatives or undertaking a social trip, were from households with a greater number of adults, are in the middle income bracket, and who see loss of bushland and open space as the most important impacts of new road investment, have a higher probability of supporting the M5 East.

When we introduce environmental attributes in the experimental design in Experiment 4 (Tables 6c and 6d) they are, without exception, not significant influences on choice of route. The largest t-value (1.8) is associated with construction cost in the MNL model; the great majority of t-values are less than 1.0. The only attribute that is statistically significant under all model conditions is the toll on the M5 East. Travel time is no longer significant except for the MNL model. Even the covariates with the exception of trip purpose are no longer influential (Table 6d), with donations to protect the environment being the next most significant influence with t-values around 1.6. Individuals travelling to visit friends and relatives or part of a social/recreation trip are more supportive of the toll road than commuters and shoppers. Why are all the environmental design attributes statistically insignificant? The answer may be due to the assessment of these attributes *for the sampled population as a whole*, as discussed in section 4.3 below.

Values of travel time savings (VTTS) are calculated to illustrate the effect of alternative model specifications on valuations in the absence of any statistically significant environmental attribute valuations. Values of travel time savings (VTTS) derived from the traditional stated choice experiment with user only attributes varied from a high of $4.78 (MNL) to a low of $2.71 (Random effects) in the absence of covariates (Table 6a), and a range of $3.55 to $2.55 when covariate effects are introduced (Table 6b). The importance of correcting for serial correlation is quite apparent; although the comparison between the SML AR1 models with 2 and 11 attributes suggests that a significant amount of the replication correlation is accommodated by the additional context specific attributes (the serial correlation declining from 0.83 to 0.17). Allowance for unobserved heterogeneity as captured by a random effects specification suggests that it is not statistically significant.

Accounting for serial correlation appears to reduce the mean estimate of the value of travel time savings; although the reduction is less, as expected, once contextual effects have taken into account part of the unobserved serial correlation. There is an important message here; namely that contextual effects can 'soak up' part (but not all) of the serial correlation. These covariates contribute substantially in closing the gap between a VTTS that is corrected for serial correlation (ie $2.88 in Table 6a) and an uncorrected VTTS (ie $3.51 in Table 6b) compared to the $4.78 (in Table 6a) when serial correlation is not corrected or covariates are not introduced.

Table 6a Use Experiment 3: User design attributes only

Attribute	Alt.	MNL	SML, AR1	SML, RE	SML, AR1, RE
Constant	Curr	-0.018 (-0.1)	-0.329 (-1.0)	-0.778 (-1.0)	-0.329 (-1.0)
DESIGN					
Traditional					
Travel time (mins)	All	-0.050 (-3.2)	-0.034 (-2.1)	-0.070 (-2.2)	-0.034 (-2.1)
Toll ($)	G/T	-0.626 (-4.7)	-0.706 (-5.9)	-1.546 (-4.9)	-0.706 (-5.9)
AR1	All		0.828 (3.0)		0.828 (6.7)
RE std deviation	All			1.918 (0.9)	0.0001 (1.0)
Log-likelihood at convergence		-193.58	-158.92	-158.51	-158.92
VTTS ($/person hr)		$4.78	$2.88	$2.71	$2.88

Notes for all Tables:

- Binary Choice: Current Free Route vs Ground or Tunnel M5 East
- Alt = Alternatives; G/T = Ground/Tunnel; Curr = Current route
- MNL = multinomial logit model; SML = simulated maximum likelihood; AR1 = autoregressive model; RE = random effects
- SML models assume a normal distribution, and MNL assumes EV1.

Notes for Tables 6a and 6b:

- 114 individuals by 3 replications.
- 75%, 65% and 68% of respondents chose their current route in each of the 3 replications.

Table 6b Use Experiment 3: User design attributes, with covariates

Attribute	Alt.	MNL	SML, AR1	SML, RE	SML, AR1, RE
Constant	Curr	.448 (0.6)	.481 (0.8)	.369 (0.4)	.764 (0.7)
DESIGN					
Traditional					
Travel time (mins)	All	-.069 (-3.0)	-.040 (-2.1)	-.056 (-2.3)	-.064 (-1.9)
Toll ($)	G/T	-1.178 (-5.6)	-.911 (-6.0)	-.946 (-5.1)	-1.512 (-2.7)
Tunnel dummy	G/T	-.384 (-1.3)	-.226 (-1.2)	-.313 (-0.5)	-.379 (-1.1)
COVARIATES					
Environmental					
Env. ranked 1	Curr	2.051 (3.3)	1.384 (2.5)	1.516 (3.0)	2.319 (1.9)
Donate $ to env.	Curr	.789 (2.0)	0.597 (1.5)	.671 (1.5)	1.046 (1.4)
Bush/space ranked 1	Curr	-.863 (-2.9)	-.758 (-2.3)	-.724 (-2.5)	-1.289 (-1.8)
Govt env impact	Curr	-.581 (-1.7)	-.409 (-1.1)	-.472 (-0.6)	-.708 (-1.1)
Personal char.					
VFR/SocRec	Curr	-1.246 (-4.3)	-1.057 (-3.4)	-1.020 (-2.7)	-1.753 (-2.2)
Female	Curr	1.834 (5.2)	1.431 (4.2)	1.473 (2.4)	2.357 (2.4)
No. of adults	Curr	-.401 (-3.1)	-.370 (-2.6)	-.315 (-1.9)	-.606 (-2.0)
Income $12k-$30k pa	Curr	-.882 (-2.5)	-.628 (-1.7)	-.701 (-1.2)	-1.006 (-1.4)
AR1	All		0.169 (4.5)		.292 (0.5)
RE std deviation	All			0.0001 (1.0)	1.320 (1.1)
Log-likelihood at convergence		-157.90	-138.02	-158.65	-137.60
VTTS ($/person hr)		$3.51	$2.62	$3.55	$2.55

Table 6c Use Experiment 4: User and environmental design attributes only

Attribute	Alt.	MNL	SML, AR1	SML, RE	SML, AR1, RE
Constant	Curr	-.485 (-0.5)	-.251 (-0.3)	-.267 (-0.2)	-.240 (-0.2)
DESIGN					
Traditional					
Travel time (mins)	All	-.031 (-1.6)	-.013 (-0.8)	-.022 (-0.9)	-.023 (-0.9)
Toll ($)	G/T	-.307 (-3.3)	-.327 (-3.5)	-.625 (-3.7)	-.654 (-3.5)
Environmental					
Houses affected by noise in region	G/T	-.001 (-1.0)	-.0003 (-0.6)	-.001 (-0.8)	-.001 (-0.9)
Houses affected by noise near road	G/T	-.002 (-1.3)	-.002 (-1.6)	-.004 (-1.5)	-.004 (-1.5)
Bush lost	G/T	-.0003 (-0.1)	-.0003 (-0.1)	.0003 (1.0)	.001 (0.1)
Open space lost	G/T	.011 (0.7)	.010 (0.6)	.020 (0.9)	.021 (0.9)
% less traffic on local streets	G/T	.006 (0.7)	.005 (0.6)	.005 (0.4)	.004 (0.3)
Visibility of road	G/T	-.194 (-0.9)	-.220 (-1.0)	-.322 (-0.9)	-.321 (-0.9)
Funding					
Govt owner of road	G/T	.123 (0.7)	.107 (0.6)	.227 (0.7)	.241 (0.8)
Toll funding dummy	G/T	.169 (0.7)	.083 (0.4)	.163 (0.4)	.172 (0.4)
Construction cost	G/T	-.002 (-1.8)	-.001 (-0.8)	-.002 (-0.8)	-.002 (-0.9)
Environment levy	G/T	.006 (0.5)	-.003 (-0.3)	.003 (0.2)	.004 (0.2)
AR1	All		.716 (2.3)		-.107 (-0.2)
RE std deviation	All			1.477 (1.4)	1.553 (1.4)
Log-likelihood at convergence		-203.709	-180.44	-177.79	-177.73

Notes:

- 113 individuals by 3 replications (1 individual only completed 2 replications and was removed).
- 68%, 64% and 66% of respondents chose their current route in each of the 3 replications.

Table 6d Use Experiment 4: User and environmental design attributes, with covariates

Attribute	Alt.	MNL	SML, AR1	SML, RE	SML, AR1, RE
Constant	Curr	.105 (0.1)	.348 (0.3)	.849 (0.5)	.955 (0.5)
DESIGN					
Traditional					
Travel time (mins)	All	-.020 (-2.1)	-.013 (-1.5)	-.021 (-1.6)	-.022 (-1.6)
Toll ($)	G/T	-.432 (-2.6)	-.350 (-3.4)	-.619 (-3.9)	-.653 (-3.6)
Environmental					
Houses affected by noise in region	G/T	-.0009 (-1.4)	-.0004 (-0.8)	-.0007 (-1.0)	-.0008 (-1.1)
Houses affected by noise near road	G/T	-.001 (-0.5)	-.002 (-1.1)	-.003 (-1.0)	-.003 (-1.0)
Bush lost	G/T	-.001 (-0.3)	-.001 (-0.3)	-.001 (-0.2)	-.001 (-0.1)
Open space lost	G/T	.011 (0.6)	.010 (0.6)	.019 (0.9)	.021 (0.9)
% less traffic on local streets	G/T	.004 (0.4)	.006 (0.6)	.005 (0.5)	.004 (0.3)
Visibility of road	G/T	-.342 (-0.7)	-.272 (-1.2)	-.394 (-1.1)	-.396 (-1.0)
Funding					
Govt owner of road	G/T	.175 (0.7)	.119 (0.6)	.242 (0.8)	.261 (0.8)
Toll funding dummy	G/T	.034 (0.1)	.017 (0.1)	.040 (0.1)	.046 (0.1)
Construction cost	G/T	-.003 (-1.7)	-.001 (-0.7)	-.001 (-0.7)	-.001 (-0.6)
Environment levy	G/T	.008 (0.6)	-.003 (-0.3)	.002 (0.1)	.004 (0.2)
COVARIATES					
Environmental					
Bush/space ranked 1	Curr	-.573 (-1.5)	-.551 (-1.3)	-.915 (-1.8)	-.953 (-1.6)
Govt env impact	Curr	-.505 (-0.6)	-.466 (-0.8)	-.863 (-1.4)	-.910 (-1.0)
Env. ranked 1	Curr	.195 (0.3)	.101 (0.2)	.130 (0.2)	.128 (0.1)
Donate $ to env.	Curr	.692 (1.6)	.668 (1.7)	1.041 (1.6)	1.066 (1.3)
Personal char.					
VFR/SocRec	Curr	-.888 (-3.0)	-.695 (-2.1)	-1.204 (-2.4)	-1.265 (-1.2)
Female	Curr	.627 (1.6)	.487 (1.0)	.840 (1.6)	.886 (0.9)
No. of adults	Curr	-.017 (-0.1)	-.029 (-0.2)	-.059 (-0.3)	-.064 (-0.3)
Income $12k-$30k pa	Curr	-.389 (-0.7)	-.270 (-0.7)	-.454 (-0.9)	-.473 (-0.7)
AR1	All		.673 (3.2)		-.132 (-0.3)
RE std deviation	All			1.342 (1.4)	1.431 (1.3)
Log-likelihood at convergence		-191.02	-172.91	-170.29	-170.20
VTTS ($/person hr)		$2.71	$2.18 (ns)	$2.03 (ns)	$1.98 (ns)

The 'Community/social' models

The second set of empirical results, reported in Tables 7a-7d, relate to an individual's evaluation of the M5 East from a community perspective (see also Table 1). In contrast to the 'self-interest' evaluation where no more than 33% of the sample chose the M5 East, in the 'community' model, over 70% chose to support the M5 East.

The only statistically significant design attributes, both positive influences on the M5 East, are being funded by a toll and government as owner (although the latter is not significant in the MNL model in the absence of covariates). Aggregate travel time savings and savings in operating costs are not seen as statistically important, in contrast to their role in the self-interest models. Correction for serial correlation is important, in contrast to the inclusion of random effects. These attributes remain statistically significant in the presence of covariates (Table 7b). Covariate effects are strong. For example (in Table 7b), regular users of the road network, car commuters and individuals who use the existing M5 road have a higher probability of supporting building the M5 East. Individuals active in donating to environmental protection have a significantly lower probability of supporting the M5 East.

In community experiment 2 (Tables 7c and 7d) where environmental design attributes are introduced, the only systematically significant design attribute is reducing traffic on local streets. The funding source is struggling to be significant but only makes it at a t-value of 2.1 when serial correlation is taken into account. This attribute can be interpreted as a measure of exposure to risk from traffic, and as such has a self-interest element, as well as implications for the safety of the community as a whole.

From the MNL model in Table 7c which is the only community model with a statistically significant parameter estimate on cost (with a t-value of 2.0 on total vehicle operating costs), a monetary valuation can be calculated as an illustration. An individual, ceteris paribus, appears to be willing to pay on average $2.93 to have a one percent reduction in traffic on local streets. The MNL result in Table 7d where covariates are introduced is $4.58; however the operating cost parameter estimate has a t-value of only 1.6. A mean willingness to pay of $2.93 per person per 1% reduction in traffic is intuitively plausible. A 10% reduction valued at $29.30 seems reasonable. What remains unclear however is the frequency with which this WTP applies. Unlike a saving in travel time that is quite unambiguous in its temporal occurrence, reductions of traffic need explicit temporal interpretation. For example, is the reduction permanent or an annual 'renewable' reduction? This is an area of further research.

The VTTS of $2.93 from the MNL model in Table 7c compares with $6.12 from the equivalent use model (Table 6c) where the environment design attributes are included but no covariates. Unfortunately in both models, travel time has a t-value of -1.5 or -1.6, considered too low for substantive comment. The only VTTS from the use models which is statistically significant in the presence of environmental design attributes and covariates is $2.71 (Table 6d). This estimate is in the same range as those from the use models without environmental design attributes after correcting for serial correlation (Tables 6a and 6b).

Table 7a Community Experiment 1: User design attributes only

Attribute	Alt.	MNL	SML, AR1	SML, RE	SML, AR1, RE
Constant	Curr	-.819 (-1.0)	-.943 (-1.9)	-2.830 (-1.9)	-2.764 (-1.9)
DESIGN ATTRIBUTES					
Traditional					
Total travel time	All	.006 (0.5)	.007 (0.8)	.025 (1.2)	.024 (1.1)
Total vehicle op costs	All	.002 (0.4)	.004 (1.2)	.008 (1.1)	.008 (1.0)
Serious accidents pa	All	-.002 (-0.9)	-.001 (-0.6)	-.001 (-0.3)	-.002 (-0.3)
Funding					
Govt owner of road	All	.305 (1.2)	.322 (2.3)	1.038 (2.6)	1.006 (2.4)
Construction cost	G/T	.0002 (0.1)	.00001 (0.0)	.0003 (0.1)	.0003 (0.1)
Funded by a toll	G/T	.460 (2.0)	.300 (2.4)	.810 (2.2)	.798 (2.6)
Tunnel dummy	G/T	.103 (0.2)	.180 (0.6)	.503 (0.6)	.495 (0.7)
AR1	All		.908 (13.1)	2.677 (1.4)	.061 (0.1)
RE std deviation	All				2.618 (1.4)
Log-likelihood at convergence		-259.99	-192.63	-191.00	-190.99

Notes for Tables 7a and 7b:

- 148 individuals by 3 replications.
- 28%, 27% and 29% of respondents chose the current road network in each replication.

Table 7b Community Experiment 1: User design attributes, with covariates

Attribute	Alt.	MNL	SML, AR1	SML, RE	SML, AR1, RE
Constant	Curr	.484 (0.5)	.502 (0.6)	1.041 (0.6)	1.038 (0.6)
DESIGN ATTRIBUTES					
Traditional					
Total travel time	All	.004 (0.3)	.006 (0.6)	.023 (1.1)	.023 (1.4)
Total vehicle op costs	All	.003 (0.6)	.003 (0.8)	.008 (1.0)	.008 (1.3)
Serious accidents pa	All	-.001 (-0.4)	-.001 (-0.3)	-.001 (-0.1)	-.000 (-0.1)
Funding					
Govt owner of road	All	.468 (1.9)	.391 (2.6)	1.155 (3.0)	1.186 (3.0)
Construction cost	G/T	.0001 (0.0)	.0001 (0.0)	.0001 (0.0)	.0001 (0.0)
Funded by a toll	G/T	.450 (1.9)	.340 (2.3)	.839 (2.3)	.846 (3.1)
Tunnel dummy	G/T	.092 (0.2)	.208 (0.6)	.606 (0.8)	.617 (0.9)
COVARIATES					
Personal benefit					
Regular user	Curr	-.619 (-2.2)	-.622 (-1.3)	-1.542 (-1.6)	-1.559 (-1.8)
Seen map of route	Curr	-.232 (-1.0)	-.181 (-0.6)	-.371 (-0.5)	-.368 (-0.5)
Car commuter	Curr	-1.074 (-4.1)	-.914 (-2.3)	-2.559 (-3.1)	-2.607 (-2.8)
Rent accomm.	Curr	-.367 (-1.1)	-.214 (-0.5)	-.607 (-0.6)	-.619 (-0.6)
M5 user	Curr	-1.791 (-2.8)	-1.545 (-1.7)	-4.148 (-2.2)	-4.214 (-2.8)
Income $12k-$30k pa	Curr	-.727 (-2.6)	-.578 (-1.6)	-1.644 (-1.8)	-1.674 (-1.7)
Funding					
Support private road	Curr	-.928 (-3.9)	-.890 (-2.8)	-2.382 (-3.0)	-2.423 (-3.1)
Environmental					
Donate $ to env.	Curr	1.177 (4.0)	1.025 (2.7)	2.635 (2.9)	2.668 (2.8)
AR1	All		.891 (10.8)		-.055 (-0.1)
RE std deviation	All			1.795 (1.4)	2.520 (1.4)
Log-likelihood at convergence		-227.48	-175.48	-173.38	-173.37

Table 7c Community Experiment 2: User and environmental design attributes

Attribute	Alt.	MNL	SML, AR1	SML, RE	SML, AR1, RE
Constant	Curr	1.351 (1.4)	.203 (0.3)	.189 (0.1)	-.033 (-0.0)
DESIGN					
Traditional					
Total travel time	All	-.020 (-1.5)	-.007 (-0.8)	-.026 (-1.2)	-.037 (-1.6)
Total vehicle op costs	All	-.010 (-2.0)	-.003 (-0.8)	-.007 (1.0)	-.006 (-0.6)
Serious accidents pa	All	-.003 (-1.0)	.000 (?)	.001 (0.2)	.002 (0.5)
Environmental					
Houses affected by noise in region	G/T	-.0003 (-0.5)	-.0002 (-0.7)	-.001 (-1.1)	-.001 (-1.1)
Houses affected by noise near road	G/T	.0002 (0.1)	.0002 (0.2)	-.0002 (-0.1)	-.001 (-0.4)
Bush lost	G/T	.0004 (0.1)	-.001 (-0.4)	-.005 (-1.1)	-.008 (-1.3)
Open space lost	G/T	-.015 (-0.9)	-.010 (-0.8)	-.022 (-0.8)	-.018 (-0.6)
% less traffic on local streets	G/T	.031 (3.6)	.019 (2.9)	.050 (3.5)	.053 (3.4)
Visibility of road	G/T	-.090 (-0.4)	-.258 (-0.9)	-.436 (-1.0)	-.414 (-0.8)
Funding					
Owner of road	All	.179 (0.9)	.127 (0.9)	.273 (0.8)	.193 (0.6)
Construction cost ($)	G/T	.002 (1.0)	.001 (0.6)	.001 (0.5)	.001 (0.6)
Funded by community	G/T	.482 (1.6)	.401 (2.1)	.958 (1.9)	.876 (1.6)
Funded by a toll	G/T	.340 (1.3)	.284 (1.8)	.822 (1.9)	.882 (2.1)
Levy to pay tunnel	G/T	-.005 (-0.4)	-.009 (-0.9)	-.028 (-1.3)	-.032 (-1.5)
Tunnel dummy	G/T	-.483 (-0.5)	.220 (0.3)	.774 (0.6)	.870 (0.7)
AR1	All		.908 (13.2)		-.519 (-1.3)
RE std deviation	All			2.817 (1.4)	3.214 (1.4)
Log-likelihood at convergence		-270.84	-204.90	-201.03	-200.12
Value of less traffic on local streets ($/1%)		$2.93	$6.20 (ns)	$6.80 (ns)	$9.07 (ns)

Notes for Tables 7c and 7d:
- 148 individuals by 3 replications.
- 36%, 39% and 33% of respondents chose the current road network in each replication.

Table 7d Community Experiment 2: User and environmental design attributes, with covariates

Attribute	Alt.	MNL		SML, AR1		SML, RE		SML, AR1, RE	
Constant	Curr	2.959	(2.8)	1.286	(1.4)	2.148	(1.4)	1.986	(1.3)
DESIGN									
Traditional									
Total travel time	All	-.014	(-1.0)	-.001	(-0.7)	-.023	(-1.2)	-.035	(-1.5)
Total vehicle op costs	All	-.009	(-1.6)	-.003	(-0.5)	-.004	(-0.6)	-.002	(-0.2)
Serious accidents pa	All	-.002	(-0.7)	-.0004	(-0.1)	.0001	(0.0)	.001	(0.3)
Environmental									
Houses affected by noise in region	G/T	-.001	(-1.2)	-.0004	(-0.7)	-.001	(-1.1)	-.001	(-1.4)
Houses affected by noise near road	G/T	-.0003	(-0.2)	-.0004	(-0.2)	-.001	(-0.5)	-.002	(-0.9)
Bush lost	G/T	-.003	(-0.8)	-.003	(-0.9)	-.007	(-1.5)	-.010	(-1.9)
Open space lost	G/T	-.021	(-1.0)	-.018	(-1.1)	-.030	(-1.1)	-.031	(-1.3)
% less traffic on local streets	G/T	.042	(4.1)	.028	(3.3)	.050	(3.6)	.053	(4.4)
Visibility of road	G/T	.055	(0.2)	-.173	(-0.8)	-.334	(-0.8)	-.311	(-0.7)
Funding									
Govt owner of road	All	.183	(0.6)	.222	(1.2)	.357	(1.0)	.281	(0.7)
Construction cost ($)	G/T	.003	(1.5)	.001	(0.8)	.002	(0.8)	.002	(0.8)
Funded by community	G/T	.802	(1.3)	.698	(2.6)	1.170	(2.3)	1.178	(1.8)
Funded by a toll	G/T	.408	(0.9)	.427	(1.9)	.812	(1.9)	.922	(1.7)
Levy to pay tunnel	G/T	-.001	(-0.1)	-.008	(-0.6)	-.019	(-0.9)	-.025	(-1.2)
Tunnel dummy	G/T	-1.665	(-1.6)	-.560	(-0.6)	-.861	(-0.7)	-.848	(-0.7)
COVARIATES									
Personal Benefit									
Lives in area 1	Curr	1.148	(2.4)	.976	(2.4)	2.020	(2.5)	2.471	(2.7)
Lives in area 2	Curr	.733	(1.6)	.557	(1.6)	1.062	(1.5)	1.217	(1.3)
25-34 years old	Curr	.704	(1.3)	.637	(1.7)	1.176	(1.5)	1.256	(1.4)
Rent accomm.	Curr	-.598	(-1.3)	-.235	(-0.6)	-.409	(-0.5)	-.408	(-0.4)
Prop value to decrease	Curr	2.293	(4.1)	1.528	(3.0)	2.956	(3.0)	3.557	(3.1)
Trip more convenient on M5 East	Curr	-.829	(-2.2)	-.534	(-1.6)	-.989	(-1.4)	-1.083	(-1.3)
Regular user	Curr	-1.442	(-4.0)	-.966	(-2.6)	-1.983	(-2.6)	-2.473	(-2.3)
Car commuter	Curr	-.942	(-2.5)	-.790	(-2.5)	-1.435	(-2.2)	-1.548	(-2.0)
Well informed	Curr	-1.051	(-3.0)	-.790	(-2.3)	-1.573	(-2.3)	-1.832	(-2.1)
Funding									
Support private road	Curr	-.981	(-3.4)	-.623	(2.1)	-1.248	(-2.1)	-1.478	(-2.0)
Building roads more important than repair	Curr	-.764	(-1.6)	-.657	(-1.8)	-1.300	(-1.7)	-1.553	(-1.7)
Environmental									
Env rank 1 for govt $s	Curr	1.637	(3.5)	.830	(1.7)	1.657	(1.8)	2.028	(1.9)
Donate $ to env.	Curr	.758	(2.2)	.420	(1.1)	0.780	(1.0)	0.788	(0.9)
Govt should consider env	Curr	.909	(2.4)	.534	(1.5)	0.979	(1.3)	-1.083	(-1.3)
AR1	All			.764	(4.7)			-.555	(-1.4)
RE std deviation	All					1.739	(1.4)	2.167	(1.4)
Log-likelihood at convergence		-194.86		-170.96		-168.29		-167.46	
Value of less traffic on local streets ($/1%)		$4.58		$10.00 (ns)		$11.36 (ns)		$29.50 (ns)	

Key Observations and Conclusions

Although the stated choice experiments were designed to reflect individual use and community perspectives (see Table 1), the empirical analysis did not support the view that respondents adopted a 'community perspective' in the processing of the environmental design attributes. Indeed there was greater support for the M5 East in the 'community perspective' experiments. The evidence that there are strong covariates that represent positions on the environment supports a view that the environmental impacts of transport projects do matter to varying degrees across the sampled population. So why are the environmental design attributes, with one exception, not statistically significant?

The design attributes are common in levels and distribution across the entire sample; as they should be. In contrast, the statistically significant contextual segmentation criteria that have a definite environmental interpretation act as shift effects, partitioning the sample and producing a distribution of environmentally-linked choice responses. The choice model findings suggest that the distribution of levels of environmental design attributes, given the choice response (ie current route versus the M5 East), fail to discriminate between the samples of individuals selecting each of the two choice alternatives (either ground or tunnel M5 East). In contrast this is not the situation for design attributes such as travel time in the 'use' model (Table 6b). The only exception is the environmental attribute 'percentage reduction in traffic on local streets' (Tables 7c and 7d), which is clearly a very positive environmental benefit supported by both those who support the status quo and those who support the M5 East, independent of any affiliation with the environmental movement. This attribute also has a self-interest component because of its links with personal safety.

In the search for further clues, we recognised different environmental impacts of the M5 East at ground level compared to a tunnel. However, this failed to reveal any significant environmental attributes for the ground vs current alternatives. In the choice design, some of the environmental attributes were not applicable for the tunnel option, such as loss of bushland and open space, and visibility. We also interacted environmental design attributes with three environmental dummy (1,0) covariates: one which identified active involvement in time and dollars with the environmental movement (17% of the sample), an indicator distinguishing individuals who ranked the environment most important for government spending (9% of the sample) and an indicator supporting the view that 'governments should do more to protect the environment even if it leads to higher taxes' (41%). On all environmental design attributes (in the use experiment), only one interaction was (marginally) significant, loss of open space for the 41% who believe that 'governments should do more to protect the environment even if it leads to higher taxes'. However it was only significant in the absence of environmental and other covariates.

A very strong message coming from the comparison of the four choice experiments is that contextual variables provide important identifiers of environmental segmentation. For example, individuals who rank the environment as highest priority for government spending, who believe that the government should be concerned about the environment, and who donate time and money to protect the environment, tend to be far less supportive of the proposed M5 East road. In contrast, individuals who are car commuters, who are more active travellers in the immediate vicinity of the proposed M5 East, and who support private investment in tollroads are much more supportive of the M5 East road. This is all very plausible. These differences imply degrees of commitment to environmental protection, regardless of whether the individual understands the potential environmental implications of major road projects.

Can we conclude that individuals appear to interpret and process choice experiments in terms of attribute proximity to self-interest, discounting attributes that are more 'distant' in direct impact on the individual? Can we thus suggest that individuals appear to process a macro summary of project benefits and costs as a search for the implications it has on their set of self-interest preferences, having little to do with any possible distinction between private (ie self-interest) and social (ie community or citizen) preferences? Maybe attributes without a direct impact on an individual are too complex to process and are ignored or heavily discounted? These questions are all reasonable hypotheses offered as possible explanations of the lack of statistical significance of environmental attributes in the stated choice design.

The reason for this may be less subtle-simply that individuals are not able to process trade-offs between attributes which are close in self-interest proximity with those that are more distant in self-interest proximity. If this is true, then it has important implications for the design of stated choice experiments. Future experiments with an interest in environmental attribute valuation should seek trade-offs between attributes within a class of equivalent self-interest proximity. Establishing such classes is an important research task, given the real possibility that distant and close self-interest may vary by respondent. In this application, the environmental attributes were "distant" in self-interest proximity for most respondents. However, for some respondents, the environmental impacts may be considered "close" in self-interest, depending on their location relative to the proposed road. Further empirical research is needed to confirm these issues.

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