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Development and test of stage-dependent conjoint choice experiments

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This article introduces and tests the method of stage-dependent conjoint choice experiments to model consumer choice of activity patterns. This design strategy allows for different model estimates in different stages of an activity pattern. It is shown how this design strategy supports the estimation of a joint logit model, a heterogeneous logit model, and a set of separate logit models. Results of an application of this approach in a study of Dutch urban tourists' choices of activity packages for a weekend in Paris are discussed. Results indicate that interactions between particular activities in different periods of the weekend are important. However, evening activities did not interact with daytime activities. For two periods of the weekend, differences in preferences were observed between activity pattern choices related to that stage of the activity pattern only and a control set of choices between patterns where all activities for the weekend varied. Tests for possible differences in evaluations of identical activities in different parts of the weekend suggested that respondents did not evaluate activities differently depending on the period of the weekend. Copyright © 1996 Elsevier Science Ltd

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Consumer choice behaviour in the retailing and consumer services area has been modelled traditionally in terms of the attributes of the choice alternatives of interest. That is, if one was interested for example in predicting the probability of store choice, the problem typically was conceptualized as the probability that a consumer would choose store $i$ as a function of its attributes and the attributes of competing stores, possibly also incorporating the socio-economic characteristics of the consumer. Thus, the notion that consumer choice behaviour may be part of more general ‘meta’-decisions has received no attention in the retailing and consumer services literature. Consumers may, however, decide on a combination of different choices in undertaking activities. For example, when making shopping trips, or when consuming recreational or cultural services in environments such as theme parks and heritage sites, consumers may combine visits to several different stores, buy several different types of goods, or participate in various different recreational activities. As a result, the outcome of their choice process is not dependent on the attributes of the competing destinations only but also on the related choices that define their total activity pattern.
An understanding of consumer activity pattern choices seems essential for developing effective marketing strategies. Consumers' activity pattern choices in many physical settings, such as shopping malls, inner cities, and theme parks, may directly influence the distribution of demand across services at different times and locations. Shops in specific areas in malls may be less popular, for example, because they cannot be visited easily in combination with other locations in the mall. Similarly, certain food outlets in theme parks or urban recreation settings may be more popular than others because they generally are encountered after spending a certain number of hours on other attractions in the park or urban environment. Moreover, activity patterns in themselves may represent an essential part of a service. This is the case for example in tourism settings, where tourists enjoy wandering from location to location while sightseeing and shopping. For shoppers who like window-shopping and browsing, retail facilities perform similar functions. Also, recreation and tourism planners and managers will typically try and develop complexes of attractions, sights and supporting facilities that offer opportunities for tourists to combine several activities and enjoy attractive activity patterns.

Thus, in many areas in the retail and services industry, complex consumer activity patterns are an integral part of the value added that is provided in the services that consumers buy. When marketing these services it therefore is highly relevant to know consumers' preferred activity patterns. Models that adequately describe consumers' activity pattern choices can be of benefit because they support ex ante evaluations of competing operational strategies. This is especially relevant, as these strategies often involve high financial risks. Therefore the possibility of simulating expected effects of planning, design and marketing strategies on consumer activity patterns in service environments can potentially greatly increase the effectiveness of marketing decisions.

Although models of activity patterns are new in the retailing and consumer services literature, various models have been developed in geography, urban planning, transportation and sociology to describe people's time-space and transportation behaviour (see Ettema and Timmermans, 1996, for a recent review). Most applications of activity pattern models to date, however, have not explicitly addressed the activities that individuals and households undertake in their role as consumers, and have paid relatively little attention to the marketing relevance of activity pattern models. Moreover, the vast majority of approaches are based on diaries, and hence have not much to offer in terms of assessing the impact of design, planning or marketing strategies on consumer choice of activity patterns, as the findings of these models are difficult to generalize to new choice options. Therefore, there is a clear need to extend stated choice analysis to the domain of activity patterns, as it allows the researcher to vary the strategies of interest and measure their impact in terms of consumer choices (Louviere and Timmermans, 1990; Carson et al, 1994; Hensher, 1994). The main advantage of stated choice techniques is that they allow one to include choice alternatives in the consumers' choice sets that currently are not available in the market. Moreover, they allow the researcher to control for correlations between attribute levels in the alternatives that are offered to respondents, implying that the influence of each attribute level on choice probabilities can be unbiasedly estimated.

The development of stated choice models of activity patterns, however, is not a trivial problem. In developing experimental designs to measure consumers' activity pattern choices, one can encounter several difficulties that are generally not encountered in traditional stated choice experiments. First, experimental choice designs for activity pattern choices differ from experimental designs for traditionally studied choice processes because they must address sets of several subsequent activity choices rather than single choice processes. This implies that designs should allow for estimations of variations in preferences that may occur over identical choices made at different moments in time. This can be the case, for example, if consumers have different preferences for activities for different parts of the day (eg morning vs evening activities), or if consumers go through a learning process when making subsequent choices. Secondly, estimation of interaction effects between preferences for alternatives at different moments in time should be supported: for example in cases where consumers seek variety between their activities or if they form habits in their behaviour over time. Thirdly, there are some modelling issues that relate to assumptions one has to make to represent the related choices and account for variance driven differences in preferences at different moments in time or between preferences for patterns and single activities.

The aim of this paper therefore is twofold. First, we wish to underline the potential relevance of activity pattern modelling for retail and services marketing, and secondly we wish to discuss some of the design and modelling principles that are relevant to develop a stated choice approach to consumer activity pattern modelling. To this end, we shall first discuss some model structures that allow one to analyse and predict consumer activity patterns. Then we shall outline a design strategy to measure consumer preferences and choices for activity patterns. An application of the suggested approach, which builds on a previous paper (Dellaert et al, 1995) is presented in the next section. The paper is concluded with a discussion of the results and an indication of potential future developments.
Models of consumer activity patterns

Following conventional stated choice models, we assume that activity patterns can be described by a set of attributes that define the activities in the patterns. When deciding which activity pattern to choose, consumers are assumed to form preferences for alternative patterns on the basis of their belief system and possible constraints. Based on their imperfect perception of their environment and various kinds of personal beliefs, dispositions, motivations, past experiences and the like, consumers derive some part-worth utility from each attribute level describing the activity pattern. They are assumed to process these utilities or evaluations according to some simple algebraic rules and arrive at some choice (e.g., Louviere, 1988).

Formally, the basic structure of the assumed choice process can be expressed as follows. Consumers attach a certain structural utility \( V_i \) to each activity pattern \( i \). This utility is a function of all attributes that describe the activities in activity pattern \( i \), and is measured with a certain error. Thus consumers’ total utility for an activity pattern \( i \) is expressed as

\[
U_i = V_i + \varepsilon_i
\]

The probability that a consumer selects alternative \( i \) equals the probability that \( U_i \) is larger than the utilities \( U_j \) of all other alternatives \( J \) in the consumer’s choice set. If it is assumed that the error components in the utility function are independently and identically distributed (IID) according to a Gumbel distribution, this probability is expressed as

\[
P(i|J) = P(U_i > U_j \forall j \neq i) = \frac{\exp(V_i)}{\sum_j \exp(V_j)}
\]

These basic assumptions are common to all conventional stated choice models. However, when examining activity patterns the actual consumer choice process may need to be conceptualized differently from conventional approaches. Different ways in which the activity pattern choice process is conceptualized have different consequences for the model specification that one would use.

The first and simplest conceptualization that we propose matches the conventional stated choice approach. In this conceptualization the choice process is regarded as a choice process where consumers go through identical trade-off processes of comparing entire activity patterns regardless of whether the patterns are completely different or have very many activities in common, or which periods of the activity pattern are involved in the choice process. An example of a situation where this type of choice process could occur would be if tourists compared a number of preset activity programmes that different tour operators offered and selected the activity programme that they found most attractive. The conceptualization assumes that consumers first develop one overall evaluation of the utility of each programme and then select the programme with the highest utility without comparing the separate components of the programmes.

Technically, the assumptions that are made in this conceptualization match those that are traditionally made in stated choice models for single activities. It is assumed that the choice process is identical in all stages of the activity pattern. This has two important model implications:

- The unexplained variances in utility measurements are independently and identically distributed (IID) across all activity patterns
- The structural utility that consumers attach to an activity pattern does not vary as consumers move through the activities in the pattern.

There is only one evaluation process that simultaneously determines the utility of all activities in the pattern.

However, when consumers make choices between activity patterns these assumptions may not be valid. The principle reason for this is that in the activity pattern choice process, different activities in the activity pattern may be evaluated in different stages of the activity pattern rather than in one overall evaluation of the total activity pattern that is made at the beginning of the activity pattern. For example, a series of interrelated subchoices (for example, timing, activity type and destination) may be made to get to the overall activity pattern choice. This implies that one has to formulate additional assumptions about how these subchoices are interacting and are integrated to arrive at the choice of a complete activity pattern.

This alternative conceptualization may affect the formal description of the activity pattern choice process in two ways. First, when activities in a pattern are evaluated in different stages of the activity pattern this implies that each evaluation may also have a different overall unexplained variance or error. In fact, this is quite likely as the number and type of activities of the pattern that are considered at each stage may vary. This implies that in the model the utility functions for different stages may have their own error components, rather than one overall error term that is identical for all activity pattern stages. Second, it can be argued that different stages in activity pattern choices may potentially lead to essentially different consumer preferences. Consumers may for example change their preferences in different stages of an activity pattern when the number of available ‘free’ activities to choose from reduces. Thus consumer preferences may change because some activities have already been
undertaken, or because commitments have already been made for later activities. If such phenomena occur, different structural utility values are required for consumers' activity choices in different stages of the activity pattern.

These two effects place different requirements on the formal model structures that are used to describe the activity pattern choice. In the following sections we shall propose three formal model structures that can correspond to the different stages of complexity. All three model structures allow for the estimation of interactions between activities that are undertaken at different periods in the pattern and for estimation of potential differences in preferences in activities between different periods of the pattern.

The first model structure is the joint logit model. This model is equivalent to the traditional conceptualization in stated choice modelling, and represents the simplest conceptualization of consumers' activity pattern choices. The second model structure is the heterogeneous logit model. This model extends the joint logit model because it allows for differences in variance between choices for different periods of the pattern. Thus it can accommodate a conceptualization of consumers' activity patterns where separate choices are made for different stages of the activity pattern at which they make the choice. The third model structure consists of a set of separate logit models for each of the stages in the activity pattern. This model structure allows both for differences in the error components in consumers' choices of activities for different stages of the pattern and for differences in the structural utility that consumers attach to the activities in each stage in the activity pattern. The three models and their properties are summarized in Table 1.

### Table 1 Model properties

<table>
<thead>
<tr>
<th></th>
<th>Interactions between periods in the activity pattern</th>
<th>Differences in variance between choice stages</th>
<th>Differences in structural utility between choice stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint logit</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Heterogeneous logit</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Set of separate logits</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

The overall utility, and that this error term is identically scaled across all activity pattern choice situations. As in the simple MNL model, it is assumed that this error term is IID Gumbel distributed (Ben-Akiva and Lerman, 1985).

Let $U_i = \sum_{n} V_{jn} e_i^n$ be the utility of the combined set of activities $\{i, ..., jN\}$. Let $N$ be the total set of periods for which activities are undertaken in the activity pattern, and $V_n$ the structural utility of activity $j$ in period $n$. Let $e_i^n$ be the error term over activity pattern $U_i = \sum_{n} V_{jn} e_i^n$, which is assumed to be IID Gumbel. Let $J_n$ be the total set of activities $j$ in period $n$, and $P((i, ..., jN))$ be the probability that activity pattern $\{i, ..., jN\}$ is chosen. Then the joint logit model for activity pattern choices is

$$U_i = \sum_{n} V_{jn} e_i^n + e_i$$

The second approach extends the joint logit model to the heterogeneous logit model (eg Allenby and Ginter, 1995; Bhat, 1995) this a logit model approach that allows one to introduce differences in error components between different choices that are observed. Therefore the model can be used to model potential differences in error components between consumer choices made in different stages of activity patterns. The heterogeneous logit model can be used if one is willing to assume that the choices that consumers make in different stages of the activity pattern vary only in terms of the error component in the utility functions used to describe the choice process, but not in the structural utilities that are attached to the activities in the pattern.

The model can be constructed as follows. Let all elements be defined as before. Let $e_i^n$ be the error term related to the activity pattern choice in stage $n \in N$, where it describes the unexplained variance in the choice involving periods $n, ..., N$ in the activity pattern. Assume that
• each of the \( n \) error terms is independently distributed of the others, and
• that all terms are Gumbel distributed with different variances.

Then the utility and choice probability of activity pattern alternative \([i_{n}, ..., j_{N}]\) in stage \( n \) is expressed as follows:

\[
U_{[i_{n}, ..., j_{N}]} = \sum_{n}^{N} V_{j_{n}} + \varepsilon_{[i_{n}, ..., j_{N}]} \tag{5}
\]

\[
P(U_{[i_{n}, ..., j_{N}]} \geq U_{[i_{n}, ..., j_{N}]} ^{\forall j 'n \in J_{n} \ j 'n \neq j_{n}} ) = \frac{\exp(\sum_{n}^{N} V_{j_{n}})}{\sum_{n \in J_{n}} \sum_{n+1 \in J_{n+1}} ... \sum_{N \in J_{N}} \exp(\sum_{n}^{N} V_{j_{n}})} \tag{6}
\]

Utilities and probabilities for alternative activity patterns in other stages are expressed analogously.

The probability that an activity pattern \([j_{1}, ..., j_{N}]\) will be undertaken is expressed as the product of the probabilities across all stages \( n \) that the activity pattern starting with activity \( j_{n} \) is selected:

\[
P(j_{1}, ..., j_{N}) = \prod_{n} P_{n}([j_{1}, ..., j_{N}]) \tag{7}
\]

where \( P([j_{n}, ..., j_{N}]) \) is the probability that activity pattern \([j_{n}, ..., j_{N}]\) is selected in stage \( n \), and \( P([j_{1}, ..., J_{N}]) \) is the overall probability that activity pattern \([j_{1}, ..., j_{N}]\) is undertaken.

The heterogeneous logit model nests the joint logit model because it reduces to the joint model if it is assumed that the error components are identical across all stages in the activity pattern.

As Swait and Louviere (1993) have discussed, differences in error components in utility functions also have a constant relationship to the parameter estimates in each choice situation. Estimates in different choice situations that have the same underlying parameters but vary in terms of the error components in the utility functions will typically lead to different parameter estimates across the choice situations. However, these parameters differ up to a constant scale factor only if the only difference between the choice sets is in the error component. This then implies that rather than being a model with separate parameters for all stages in the activity pattern, the heterogeneous logit model is a model with identical structural utility parameters across all stages and a set of \( N - 1 \) scale corrections between all stages \( N \). If all scale corrections are equal to 1, the model reduces to the joint logit model.

More specifically, the ratio \( r_{1-n} \) of the scales (\( \mu^{1} \) and \( \mu^{n} \)) of choice situations \( l \) and \( n \) can be expressed in terms of the standard deviations of the error terms of those choice situations (\( \sigma_{l} \) and \( \sigma_{n} \)):

\[
r_{1-n} = \frac{\mu^{1}}{\mu^{n}} = \frac{\sigma_{n}}{\sigma_{l}} \tag{8}
\]

If the scale of the variance in choice situation 1 is arbitrarily set to 1 then the variance in choice situation \( n \) can be expressed as

\[
\text{var}(\varepsilon_{n}) = \frac{\pi^{2}}{6} r_{1-n}^{2} \tag{9}
\]

because the variance of the Gumbel distribution for the error component in situation 1 equals \( \pi^{2}/6 \) if the distribution is set to 1 (Ben-Akiva and Lerman, 1985).

**Set of separate logit models**

The third modelling approach that we propose is a set of separate logit models for each of the different stages in the activity pattern. This model allows for different parameters for each of the stages in the activity pattern.

Separate logit models of different activities should be used if choices for different activity pattern stages are expected to be essentially different: for example, if consumers may change their preferences when some activities have been undertaken, or when commitments have been made for later activities. The set of models can be expressed as follows. Let all elements be defined as before. Assume that the underlying structural utilities for each stage in the activity pattern choice process are different. Let \( V_{j_{n}} \) represent the structural utility of alternative \( j_{n} \) in activity pattern \([j_{n}, ..., j_{N}]\) in stage \( n \); then the utility and choice probability of activity pattern alternative \([j_{n}, ..., j_{N}]\) in stage \( n \) is expressed as follows:

\[
U_{[j_{n}, ..., j_{N}]} = \sum_{n}^{N} V_{j_{n}} + \varepsilon_{[j_{n}, ..., j_{N}]} \tag{10}
\]

\[
P(U_{[j_{n}, ..., j_{N}]} \geq U_{[j_{n}, ..., j_{N}]} ^{\forall j 'n \in J_{n} \ j 'n \neq j_{n}} ) = \frac{\exp(\sum_{n}^{N} V_{j_{n}})}{\sum_{n \in J_{n}} \sum_{n+1 \in J_{n+1}} ... \sum_{N \in J_{N}} \exp(\sum_{n}^{N} V_{j_{n}})} \tag{11}
\]

Utilities and probabilities for alternative activity patterns in other stages are expressed analogously.

The probability that an activity pattern \([j_{1}, ..., j_{N}]\) will be undertaken is again expressed as the product across all stages \( n \) of the probabilities that the activity pattern starting with activity \( j_{n} \) is selected. The separate logit models nest the heterogeneous logit model, which arises if the structural utilities \( V_{j_{n}} \) are identical across all stages \( n \).

**Design issues**

Experimental designs to support stated choice experiments typically depend on the assumption
that consumers' choices between alternatives are based on latent preference functions relating consumers' utilities for alternatives to the attributes of those alternatives (e.g., Louviere and Woodworth, 1983; Timmermans, 1984; Bates, 1988, Louviere, 1988). It is typically assumed that these preference functions consist of a structural part \( V_i \) and a stochastic part \( e_i \), and that the stochastic terms across alternatives \( i \) are independently and identically distributed.

A necessary and sufficient condition to estimate the parameters in this type of model efficiently is that the experimental design used to create the choice alternatives is orthogonal. An orthogonal design guarantees that attributes within choice alternatives vary independently. One commonly applied design strategy is to create an orthogonal fractional factorial design and then place the profiles from this design in choice sets. Typically, a base alternative is added to each choice set to obtain orthogonality between the relative differences of the alternatives. In that case, all estimates are made in relation to the same base alternative.

Variable- or constant-choice set designs may be used to create the choice sets. In the case of variable-choice sets, \( 2^s \) designs, where \( N \) is the total number of profiles, are typically applied to vary the absence or presence of profiles in choice sets. The two levels indicate that an alternative can be either absent or present in the choice set. Thus choice sets of varying size and composition are created.

In constant-choice set designs, various approaches may be adopted. Two commonly applied techniques are as follows:

- Each alternative \( i \) in the choice set of fixed size \( s \) is described in terms of \( j \) attributes with levels \( \ell_j \). The attributes are placed in choice sets of size \( s \) according to a fractional factorial design in which all levels are varied independently. For example, if one wishes to conduct an experiment with two alternatives with three and four attributes, all with three levels, a \( 3^7 \) fractional factorial design is created to construct choice sets in which attributes vary independently both within and between alternatives.

- Alternative profiles from \( k \) identical fractional factorial designs are randomly combined to create choice sets of size \( k \), preventing that identical alternatives are placed in the same choice set. In principle, randomization of attribute comparisons renders the marginals of the alternatives independent of each other. Independence between the attributes describing the various alternatives can be tested by calculating the correlations between the all combinations of columns of the combined design profiles. If the marginals are fully independent the correlations are zero (Louviere, 1988). Alternatively, a principal component analysis can be run on the design to test whether certain columns can be constructed from combinations of other columns.

As we have argued in the previous sections, experimental designs that allow one to estimate the models discussed before should support estimates of:

- interaction effects between preferences for alternatives undertaken at different moments in time;
- differences in the error components between activity choices at different stages in the activity pattern; and
- variations in preferences that may occur over different stages of the activity pattern.

To allow for this, we propose an activity pattern stage-dependent experimental approach that combines a set of experimental designs for different configural types of pattern choices. In our approach, consumers are presented with choice sets drawn from different experimental designs, each describing choices at different stages in the activity pattern. Thus differences between choices that consumers make at different stages in the activity pattern can be detected. The aim of the proposed approach is to support model estimates and model comparisons across different stages of activity pattern choices. This can be done by first estimating separate models for each of the activity pattern stages (that is, for each of the experimental designs) and then comparing and testing the differences between the models.

Choices that consumers make in each stage in the activity pattern can potentially involve an evaluation of all alternatives that can be undertaken in future periods of the activity pattern. If all future activities are incorporated in the experimental design for the activity pattern choice tasks for different stages in the activity pattern choice, this may lead to a set of relatively large experimental designs. The reason is that for each stage the impact of possible future activities on the choice of an activity for that stage needs to be estimated, which requires designs for each stage that incorporate the activities for all remaining periods. In the design approach that we propose, we propose to control some of this complexity. We propose to control for the potential impact of future activities in each stage \( n \) by maintaining all activities for other periods than period \( n \) constant in the choice experiment. Thus, in the choice for each stage \( n \), only the activities for that the period related to stage \( n \) will affect the choice in the experimental task. By using separate experimental designs for each of the choice stages we can then estimate models for the choices that consumers make in each stage.

For example, consumers' activity choices could be studied for stage \( n \) in an \( N \) period activity pattern. Respondents would then be asked to choose between activity patterns that consisted of identical
activities for all five periods of the pattern except for period \( n \). The activities describing the other periods would vary between choice sets to guarantee independent estimates from two-way interactions between periods, but they would not vary within choice sets. This procedure is repeated for all stages. Thus separate models can be estimated for each stage of the activity pattern. This models represent the separate logit model structure that was discussed before.

To compare this structure with the more parsimonious heterogeneous and joint logit models it is proposed that another experimental design is added to the above designs. This additional design would be similar to a traditional experimental design for single alternatives in that it creates activity patterns from a set of activities for each period similarly to the way choice alternatives are created from attributes in traditional stated choice studies. For example, if an activity pattern contained activities for \( N \) periods, each with four possible activities, then a \( 4^N \) fractional factorial design would be used.

The reason why this additional design is added is that it allows one to compare the choices made in the different stages with choices between activity patterns that involve all combined activities. If the heterogeneous logit model applies we would expect to find that the parameter estimates for each of the separate stages in the pattern would be identical to those for the full activity pattern up to a scale correction for differences in the error component in the models. In the case of the joint logit model the parameters would not even need to be corrected for differences in the error components.

Summarizing, the following designs are proposed to estimate the models:

- A set of \( N \) conditional subdesigns is constructed in which for each stage \( n \) only the activities of the activity pattern alternatives vary in each choice set and where other activities are maintained as a constant condition.
- One subdesign is constructed in analogy to traditional designs for single choices, with the difference that attributes from \( N \) activities instead of the attributes of only one activity are used to construct activity pattern alternatives.

This design strategy allows one to compare activity pattern choices for each of the \( n \) choice stages, with choices that are made between activity patterns that are completely different in all their activities.

Interactions between periods can be addressed in each of the subdesigns that are presented to the respondents. The requirement to do this is to set up the experimental design in such a way that interactions between activities in different periods of the activity pattern can be estimated independently of the main effects for these periods. Potential differences in preferences for activities when undertaken at different moments in time or in different sequential positions can be determined by allowing these activities to re-occur in several periods in the design.

A schematic representation of the experimental design strategy for activity pattern choices regarding \( N \) different activities is given below:

\[
\begin{align*}
\text{choices for stage 1} & \quad \text{choices among activity patterns} \\
& \quad \text{that differ only for period 1} \\
\ldots \\
\text{choices for stage } N & \quad \text{choices among activity patterns} \\
& \quad \text{that differ only for period } N \\
\text{choices among activity patterns} & \quad \text{that are completely different}
\end{align*}
\]

**Estimation**

This can be done in two stages:

- First it is tested whether the parameters related to the activities in the activity pattern are identical across choice set configurations, but that differences may exist between the configurations in terms of their unobserved variances.
- Secondly it is tested whether or not the differences in unobserved variances between the choice situations are significant or not.

In the estimation, first separate logit models are estimated for the choices in each of the different activity pattern stages in each of the separate experimental designs and for the experimental design with the combined activity patterns. This is feasible because disturbances within each subdesign will be IID for each of the three proposed modelling conditions. It is assumed that consumer choice processes have IID error components for each of the activity pattern stages. Therefore, even if the separate logit models or the heterogeneous logit model are the true model structure, parameters can be estimated consistently within each subdesign by using logit models that are based on IID Gumbel disturbances.

In the next estimation stage, an overall heterogeneous logit is estimated across all choice stages and the combined activity pattern choices. This model allows for different error components between the various activity pattern choices. Because separate designs are used to create the experimental choice sets for each stage, differences in error components between stages can be estimated independently. This is required to estimate the proposed heterogeneous logit model, where differences in variances exist between the different choice stages.

Because the parameters of the conditional subdesigns are estimated from a set of independent subdesigns, a sequential estimation procedure can be used.
to determine the variance corrections that maximize the overall log-likelihood of the heterogeneous logit model. This procedure guarantees a global maximum in the log-likelihood but does not provide estimates of the variance on the variance corrections themselves. In comparing models this is not a major drawback, as the log-likelihood ratio test statistic compares the total fit of the models rather than the separate parameter estimates. It is important to note that this estimation is efficient only if the true underlying model in each subdesign has IID disturbances.

The heterogeneous logit model structure is tested against the separate logit models in a log-likelihood ratio test. It is tested whether the sum of the log-likelihoods of the separate models is not significantly better than that of the heterogeneous logit model. The test tests the additional explanatory power of the additional variables in the separate logit models against the more parsimonious heterogeneous logit model. Formally the test criterion is expressed as:

\[2[L(\text{separate models}) - L(\text{heterogeneous logit model})]\]

which is chi-square distributed with a degree of freedom equal to the difference in number of explanatory variables between the models.

If the heterogeneous logit model is not rejected against the separate models it can then be tested against the joint logit model, again using the log-likelihood ratio test.

Application: urban tourists' choice of activity packages

Though several studies in urban tourism have described aspects of urban tourists' activity choices (Jansen-Verbeke, 1988; Murphy, 1992), only little research is available on urban tourists' evaluations and choices of activity patterns (Dietvorst, 1993). Urban tourists' preferences for different activity patterns may have important managerial consequences in planning and marketing urban tourist destinations. Marketing and planning strategies that focus on tourists' evaluations of separate activities, when in fact tourists' evaluations of combinations of activities determine their choices, may lead to erroneous decisions about marketing and development strategies (Morey et al, 1991; Dietvorst, 1993).

Method

Data for this study were collected in May 1994 in the Eindhoven region of the Netherlands.

A random sample of 60 streets was drawn from the map of the region and in each street a convenience sample of 10 households was selected who agreed to participate in the survey. Questionnaires were delivered and later collected at the household address. Households also were given the opportunity to send the questionnaire back by mail. A total of 510 completed questionnaires were collected. For the analysis presented in this study only data were used from respondents that indicated that they had visited Paris in the past three years. This group represents 221 respondents of the sample, which is 43%.

Alternatives were presented to the respondents in an experimental choice task, which described a weekend in Paris in four time periods: Saturday morning, Saturday afternoon and Saturday evening, and Sunday morning. These are the most common time periods in Dutch tourists' weekend trips to Paris. A three-level attribute described the possible activities for each time period. The activities used to describe the hypothetical activity packages were selected on the basis of results of previous research on urban tourism, where they were found to be the activities that were undertaken most frequently by urban tourists (Jansen-Verbeke, 1988; Woodside et al, 1989). The levels used to describe the Saturday morning activity were:

- for Saturday morning: shopping, make a bus tour and sightseeing;
- for Saturday afternoon they were: shopping, a non-guided walk in the city and sightseeing;
- for Saturday evening: visit a show, make a bus tour by night and have a drink in a café;
- for Sunday morning: visit a museum, a non-guided walk in the city and sightseeing.

A base alternative was added to all choice sets. It was described as a non-guided walk in the city on Saturday morning, a visit to a museum on Saturday afternoon, stay in the hotel on Saturday evening, and make a bus tour on Sunday morning. An overview of the attribute levels is provided in Tables 2–5, which present the model estimates for the different stages in the activity pattern.

Four experimental designs were used, one for each of the stages in the activity pattern. The design for each stage was created by varying a three-level variable describing possible activities for the period pertinent to that stage. These variable were varied independently of the other activities, which in the choice tasks were conditional to the choice. A 3^4 full factorial design in 81 profiles was used to construct the profiles in the experimental choice task for the combined activity pattern choices. This design supported the estimation of main effects and all two-way interactions between main effects. Choice sets were created by randomly combining alternatives from two identical 3^4 designs, with the restriction that the alternatives of each choice set should have different descriptions for all attributes. The base alternative was added to each choice set.

The choice tasks were presented to the respondents as part of a larger questionnaire. Each respondent was presented with two choice sets systematically drawn.
from the experimental designs for the different choice stages and with five or six choice sets drawn from a randomization of all choice sets in the design describing the combined activity pattern choices. Fifteen respondents represented one complete replication of all experimental designs. For each choice set, respondents were asked to choose the activity pattern that they found most attractive. In the analysis, observations were aggregated across all respondents.

### Results

Tables 2–5 present the results for the different staged in the activity pattern. Estimates represent utility values of the main effects of the first and second level of each attribute as compared with the third level. The intercept represents the value of the average utility of the alternatives each stage as compared with the base activity in that period. The

### Table 2 Utility values of the attribute levels and their significance for Saturday morning activity pattern stage

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Levels</th>
<th>Parameter estimates</th>
<th>Standard error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>-0.158 45</td>
<td>0.205 51</td>
<td>-0.771</td>
</tr>
<tr>
<td>Saturday morning</td>
<td>Shopping</td>
<td>-0.732 52</td>
<td>0.193 45</td>
<td>-3.787</td>
</tr>
<tr>
<td></td>
<td>Make a bus tour</td>
<td>0.063 93</td>
<td>0.230 38</td>
<td>0.262</td>
</tr>
<tr>
<td></td>
<td>Sightseeing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

McFadden’s rho-square: 0.2325

### Table 3 Utility values of the attribute levels and their significance for Saturday afternoon activity pattern stage

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Levels</th>
<th>Parameter estimates</th>
<th>Standard error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>0.361 64</td>
<td>0.212 72</td>
<td>1.700</td>
</tr>
<tr>
<td>Saturday afternoon</td>
<td>Shopping</td>
<td>-0.617 57</td>
<td>0.163 95</td>
<td>-3.767</td>
</tr>
<tr>
<td></td>
<td>Non-guided walk</td>
<td>0.742 34</td>
<td>0.213 36</td>
<td>-3.479</td>
</tr>
<tr>
<td></td>
<td>Sightseeing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

McFadden’s rho-square: 0.2182

### Table 4 Utility values of the attribute levels and their significance for Saturday evening activity pattern stage

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Levels</th>
<th>Parameter estimate</th>
<th>Standard error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>2.003 24</td>
<td>0.392 85</td>
<td>5.099</td>
</tr>
<tr>
<td>Saturday evening</td>
<td>Visit a show</td>
<td>-0.142 49</td>
<td>0.137 40</td>
<td>-1.037</td>
</tr>
<tr>
<td></td>
<td>A bus tour by night</td>
<td>-0.316 36</td>
<td>0.204 62</td>
<td>-1.546</td>
</tr>
<tr>
<td></td>
<td>A drink in a café</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

McFadden’s rho-square: 0.5105

### Table 5 Utility values of the attribute levels and their significance for Sunday morning activity pattern stage

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Levels</th>
<th>Parameter estimate</th>
<th>Standard error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>0.648 82</td>
<td>0.233 09</td>
<td>2.784</td>
</tr>
<tr>
<td>Sunday morning</td>
<td>Visit a museum</td>
<td>0.023 27</td>
<td>0.140 56</td>
<td>0.166</td>
</tr>
<tr>
<td></td>
<td>Non-guided walk</td>
<td>0.371 27</td>
<td>0.197 20</td>
<td>1.883</td>
</tr>
<tr>
<td></td>
<td>Sightseeing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

McFadden’s rho-square: 0.1781
<table>
<thead>
<tr>
<th>Attributes</th>
<th>Levels</th>
<th>Parameter estimates</th>
<th>Standard error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>1.792 53</td>
<td>0.114 80</td>
<td>15.614</td>
</tr>
<tr>
<td>Saturday morning</td>
<td>1 Shopping (SaMo-Shop)</td>
<td>-0.202 50</td>
<td>0.060 88</td>
<td>-3.326</td>
</tr>
<tr>
<td></td>
<td>2 Make a bus tour (SaMo-Bus)</td>
<td>-0.147 89</td>
<td>0.057 76</td>
<td>-2.560</td>
</tr>
<tr>
<td></td>
<td>3 Sightseeing (SaMo-Sight)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday afternoon</td>
<td>1 Shopping (SaAf-Shop)</td>
<td>-0.218 60</td>
<td>0.057 66</td>
<td>-3.791</td>
</tr>
<tr>
<td></td>
<td>2 Non-guided walk (SaAf-Walk)</td>
<td>0.016 74</td>
<td>0.056 76</td>
<td>0.295</td>
</tr>
<tr>
<td></td>
<td>3 Sightseeing (SaAf-Sight)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday evening</td>
<td>1 Visit a show (SaEv-Show)</td>
<td>0.095 03</td>
<td>0.055 76</td>
<td>1.704</td>
</tr>
<tr>
<td></td>
<td>2 A bus tour by night (SaEv-Tour)</td>
<td>-0.038 09</td>
<td>0.056 80</td>
<td>-0.671</td>
</tr>
<tr>
<td></td>
<td>3 A drink in a café (SaEv-Café)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunday morning</td>
<td>1 Visit a museum (SuMo-Muse)</td>
<td>-0.107 03</td>
<td>0.058 34</td>
<td>-1.835</td>
</tr>
<tr>
<td></td>
<td>2 Non-guided walk (SuMo-Walk)</td>
<td>-0.093 31</td>
<td>0.057 73</td>
<td>-1.616</td>
</tr>
<tr>
<td></td>
<td>3 Sightseeing (SuMo-Sight)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

McFadden’s rho-square without interactions: 0.4672

Significance of the estimates is also presented. The fit of the models is satisfactory, with McFadden’s rho-square values of 0.2525, 0.2182, 0.5105, and 0.1782.

Table 6 presents the results for the combined activity pattern choices, and estimates for interaction effects and their significance are presented in Table 7. The value of these interaction effects is relatively hard to interpret. They represent the combined utility of the main effect contrasts across two different periods of the activity pattern. The overall fit of the model was satisfactory both with and without interactions, with McFadden’s rho-square values of 0.5454 and 0.4672 respectively.

The parameter estimates in Table 6 show that on average respondents strongly preferred all other options over the unattractive base alternative. Sightseeing was considered the most attractive activity for each of the three daytime periods of the activity pattern. Walking around the city was considered equally attractive as sightseeing for the Saturday afternoon but not for Sunday morning. Shopping was clearly less attractive than sightseeing. The scores for shopping for Saturday morning and Saturday afternoon were very similar. The difference in evaluation of the possible activities for the Saturday evening was not significant.

Three interaction effects were statistically significant at the 0.05% reliability level, and three more were significant at the 0.10% level. The most significant interaction indicated that respondents had a very low utility for selecting shopping for both Saturday morning and Saturday afternoon, indicating a tendency of respondents to seek variety in their activities. The other interactions are harder to interpret, because they relate to mixed contrast, depending on what periods of the activity pattern they are related to. The seventh interaction effect, for example, describes the interaction between the contrasts in attribute levels making a bus tour–sightseeing in period 1 on the one hand and shopping–sightseeing in period 2 on the other hand. Its positive value indicates that the combinations making a bus tour–shopping and sightseeing–sightseeing for periods 1 and 2 are evaluated more positively than the other two possible combinations: making a bus tour–sightseeing and shopping–sightseeing. Similar interpretation apply to the other interactions.

Two tests for differences in attribute evaluations in different periods of the weekend were conducted for the combined activity pattern choice task:

- between shopping on Saturday morning and Saturday afternoon, and
- between a non-guided walk on Saturday afternoon and Sunday morning.

Log-likelihood ratio tests were conducted to test the difference between the models with different and identical parameter estimates on these attribute levels for the different parts of the weekend. The results are presented in Table 8, and reveal that the model in which the compared attribute levels were identical was not significantly different from the model in which they were allowed to be different. Hence for these attributes there is no difference in utility between the periods of the weekend in which they would be undertaken.

Next, the heterogeneous logit model was estimated across the activity pattern choices for each of the stages and the combined activity pattern choices. Table 9 presents the results of this estimation. Only two of the variance corrections between the conditional choice set configurations and the combined choice set configuration were significant. Both the estimates for the conditional Saturday morning choices and the conditional Saturday afternoon choices had a significantly lower variance than the combined choices. The scale corrections for variances for these two stages were 0.4322 and 0.3351 respectively. The scale corrections on the choices for
## Consumer activity pattern choice

### Table 7 Utility values and significance for interaction effects in combined activity pattern choices

<table>
<thead>
<tr>
<th>Interaction effects</th>
<th>Parameter estimate</th>
<th>Standard error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SaMo-Shop,SaAf-Shop) or (SaMo-Sight,SaAf-Sight) vs (SaMo-Shop,SaAf-Sight)</td>
<td>-0.643 44</td>
<td>0.135 16</td>
<td>-4.761</td>
</tr>
<tr>
<td>(SaMo-Shop,SaAf-Sight) or (SaMo-Sight,SaAf-Shop) vs (SaMo-Shop,SaAf-Walk)</td>
<td>0.032 77</td>
<td>0.108 77</td>
<td>0.301</td>
</tr>
<tr>
<td>(SaMo-Shop,SaEv-Show) or (SaMo-Sight,SaEv-Café) vs (SaMo-Shop,SaEv-Café) or (SaMo-Sight,SaEv-Show)</td>
<td>-0.015 18</td>
<td>0.104 70</td>
<td>-0.145</td>
</tr>
<tr>
<td>(SaMo-Shop,SaEv-Tour) or (SaMo-Sight,SaEv-Café) vs (SaMo-Shop,SaEv-Café) or (SaMo-Sight,SaEv-Tour)</td>
<td>0.123 85</td>
<td>0.117 60</td>
<td>1.053</td>
</tr>
<tr>
<td>(SaMo-Shop,SuMo-Muse) or (SaMo-Sight,SuMo-Sight) vs (SaMo-Shop,SuMo-Sight) or (SaMo-Sight,SuMo-Muse)</td>
<td>-0.217 98</td>
<td>0.131 75</td>
<td>-1.654</td>
</tr>
<tr>
<td>(SaMo-Shop,SuMo-Walk) or (SaMo-Sight,SuMo-Sight) vs (SaMo-Shop,SuMo-Sight) or (SaMo-Sight,SuMo-Walk)</td>
<td>0.054 01</td>
<td>0.120 97</td>
<td>0.446</td>
</tr>
<tr>
<td>(SaMo-Bus,SaAf-Shop) or (SaMo-Sight,SaAf-Sight) vs (SaMo-Bus,SaAf-Sight) or (SaMo-Sight,SaAf-Shop)</td>
<td>0.246 04</td>
<td>0.112 75</td>
<td>2.182</td>
</tr>
<tr>
<td>(SaMo-Bus,SaAf-Walk) or (SaMo-Sight,SaAf-Sight) vs (SaMo-Bus,SaAf-Sight) or (SaMo-Sight,SaAf-Walk)</td>
<td>-0.182 93</td>
<td>0.113 06</td>
<td>-1.618</td>
</tr>
<tr>
<td>(SaMo-Bus,SaEv-Show) or (SaMo-Sight,SaEv-Café) vs (SaMo-Bus,SaEv-Café) or (SaMo-Sight,SaEv-Show)</td>
<td>0.139 27</td>
<td>0.116 09</td>
<td>1.200</td>
</tr>
<tr>
<td>(SaMo-Bus,SaEv-Tour) or (SaMo-Sight,SaEv-Café) vs (SaMo-Bus,SaEv-Café) or (SaMo-Sight,SaEv-Tour)</td>
<td>-0.074 70</td>
<td>0.112 23</td>
<td>-0.666</td>
</tr>
<tr>
<td>(SaMo-Bus,SuMo-Muse) or (SaMo-Sight,SuMo-Sight) vs (SaMo-Bus,SuMo-Sight) or (SaMo-Sight,SuMo-Muse)</td>
<td>0.047 82</td>
<td>0.116 42</td>
<td>0.411</td>
</tr>
<tr>
<td>(SaMo-Bus,SuMo-Walk) or (SaMo-Sight,SuMo-Sight) vs (SaMo-Bus,SuMo-Sight) or (SaMo-Sight,SuMo-Walk)</td>
<td>-0.351 86</td>
<td>0.124 94</td>
<td>-2.816</td>
</tr>
<tr>
<td>(SaAf-Shop,SaAf-Shop) or (SaAf-Sight,SaAf-Sight) vs (SaAf-Shop,SaAf-Sight) or (SaAf-Sight,SaAf-Shop)</td>
<td>-0.122 64</td>
<td>0.116 39</td>
<td>-1.054</td>
</tr>
<tr>
<td>(SaAf-Shop,SaAf-Walk) or (SaAf-Sight,SaAf-Sight) vs (SaAf-Shop,SaAf-Walk) or (SaAf-Sight,SaAf-Walk)</td>
<td>0.031 95</td>
<td>0.107 05</td>
<td>0.298</td>
</tr>
<tr>
<td>(SaAf-Shop,SaEv-Show) or (SaAf-Sight,SaEv-Sight) vs (SaAf-Shop,SaEv-Sight) or (SaAf-Sight,SaEv-Tour)</td>
<td>-0.032 97</td>
<td>0.127 74</td>
<td>-0.258</td>
</tr>
<tr>
<td>(SaAf-Shop,SaEv-Walk) or (SaAf-Sight,SaEv-Sight) vs (SaAf-Shop,SaEv-Walk) or (SaAf-Sight,SaEv-Walk)</td>
<td>-0.130 65</td>
<td>0.123 42</td>
<td>-1.059</td>
</tr>
<tr>
<td>(SaAf-Walk,SaAf-Shop) or (SaAf-Sight,SaAf-Sight) vs (SaAf-Walk,SaAf-Sight) or (SaAf-Sight,SaAf-Shop)</td>
<td>0.105 95</td>
<td>0.111 75</td>
<td>0.948</td>
</tr>
<tr>
<td>(SaAf-Walk,SaAf-Walk) or (SaAf-Sight,SaAf-Walk) vs (SaAf-Walk,SaAf-Walk) or (SaAf-Sight,SaAf-Walk)</td>
<td>-0.003 65</td>
<td>0.106 95</td>
<td>-0.034</td>
</tr>
<tr>
<td>(SaAf-Walk,SaAf-Muse) or (SaAf-Sight,SaAf-Sight) vs (SaAf-Walk,SaAf-Sight) or (SaAf-Sight,SaAf-Muse)</td>
<td>0.218 98</td>
<td>0.123 20</td>
<td>1.777</td>
</tr>
<tr>
<td>(SaAf-Walk,SaEv-Show) or (SaAf-Sight,SaEv-Sight) vs (SaAf-Walk,SaEv-Sight) or (SaAf-Sight,SaEv-Walk)</td>
<td>-0.193 20</td>
<td>0.133 67</td>
<td>-1.445</td>
</tr>
<tr>
<td>(SaEv-Show,SaAf-Shop) or (SaEv-Sight,SaAf-Sight) vs (SaEv-Show,SaAf-Sight) or (SaEv-Sight,SaAf-Shop)</td>
<td>-0.198 40</td>
<td>0.107 74</td>
<td>-1.841</td>
</tr>
<tr>
<td>(SaEv-Show,SaAf-Walk) or (SaEv-Sight,SaAf-Walk) vs (SaEv-Show,SaAf-Walk) or (SaEv-Sight,SaAf-Walk)</td>
<td>-0.041 86</td>
<td>0.121 01</td>
<td>-0.346</td>
</tr>
<tr>
<td>(SaEv-Tour,SaAf-Muse) or (SaEv-Sight,SaAf-Muse) vs (SaEv-Tour,SaAf-Muse) or (SaEv-Tour,SaAf-Muse)</td>
<td>0.110 63</td>
<td>0.117 69</td>
<td>0.940</td>
</tr>
<tr>
<td>(SaEv-Tour,SaAf-Walk) or (SaEv-Sight,SaAf-Walk) vs (SaEv-Tour,SaAf-Walk) or (SaEv-Tour,SaAf-Walk)</td>
<td>0.137 21</td>
<td>0.122 55</td>
<td>1.120</td>
</tr>
</tbody>
</table>

McFadden's rho-square including interactions: 0.5454

The other stages, however, took on negative values. This implies that the differences in parameter values between choices for these stages and the choices for the combined activity patterns could not be explained by differences in error components between the types of choices. The parameters for these choices were essentially different.

This finding implies that the overall heterogeneous logit model did not perform significantly worse from a set of separate logit models for the first two stages in the activity pattern, but that it did perform significantly worse for the second two stages.

A further test was conducted using the log-likelihood ratio test. The model structure of separate models with different parameters for all activity pattern stages and the combined activity pattern choices was tested against the heterogeneous logit model where only the variances were different between the choice set configurations. In this test the log-likelihood of the heterogeneous logit model was compared with the sum of the log-likelihoods of the separate models. The value of the statistic was 23.75, which is significant at the 0.05 level in a chi-square test at 11 degrees of freedom (the number of extra parameters in the separate models).
Table 8 Test of differences in parameter values for identical attributes in different periods

<table>
<thead>
<tr>
<th>Model</th>
<th>Log-likelihood</th>
<th>Chi-square value of difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different parameter values for all periods of the weekend</td>
<td>-241.46</td>
<td>-</td>
</tr>
<tr>
<td>Identical parameter values for shopping on Saturday morning and afternoon</td>
<td>-241.47</td>
<td>0.02</td>
</tr>
<tr>
<td>Identical parameter values for shopping and the non-guided tour on Saturday afternoon and Sunday morning</td>
<td>-241.71</td>
<td>0.48 0.46</td>
</tr>
</tbody>
</table>

The critical chi-square value for one degree of freedom at the 0.95 level is 3.84.

Table 9 Utility values of the attribute levels and their significance: overall estimates across choice stages and combined activity pattern choices: main effects only

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Levels</th>
<th>Parameter estimate</th>
<th>Standard error</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td></td>
<td>1.764 50</td>
<td>0.111 90</td>
<td>15.569</td>
</tr>
<tr>
<td>Saturday morning</td>
<td>Shopping</td>
<td>-0.484 48</td>
<td>0.102 10</td>
<td>-4.745</td>
</tr>
<tr>
<td></td>
<td>Make a bus tour</td>
<td>-0.318 90</td>
<td>0.108 45</td>
<td>-2.940</td>
</tr>
<tr>
<td></td>
<td>Sightseeing</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Saturday afternoon</td>
<td>Shopping</td>
<td>-0.650 14</td>
<td>0.113 31</td>
<td>-5.561</td>
</tr>
<tr>
<td></td>
<td>Non-guided walk</td>
<td>0.380 33</td>
<td>0.124 39</td>
<td>3.058</td>
</tr>
<tr>
<td></td>
<td>Sightseeing</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Saturday evening</td>
<td>Visit a show</td>
<td>0.010 37</td>
<td>0.048 27</td>
<td>1.039</td>
</tr>
<tr>
<td></td>
<td>A bus tour by night</td>
<td>-0.000 97</td>
<td>0.050 46</td>
<td>-0.254</td>
</tr>
<tr>
<td></td>
<td>A drink in a café</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sunday morning</td>
<td>Visit a museum</td>
<td>-0.119 20</td>
<td>0.048 45</td>
<td>-2.460</td>
</tr>
<tr>
<td></td>
<td>Non-guided walk</td>
<td>-0.050 30</td>
<td>0.049 79</td>
<td>-1.010</td>
</tr>
<tr>
<td></td>
<td>Sightseeing</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Conclusions and discussion

The main purpose of this study was to introduce and test a stated choice approach to modelling consumer choice of activity pattern. A joint logit model, a heterogeneous logit model and a set of separate logit models were introduced to model choices between activity patterns. An experimental design approach was used that included multiple alternatives, interactions between alternatives, and different choice tasks for different stages in activity patterns. The approach allows for tests of possible differences in parameter values for identical attributes when introduced in different periods of the weekend.

The approach was implemented in a case study on Dutch urban tourists' choices of activity packages for a weekend in Paris. Respondents were asked to choose from different hypothetical descriptions of activity packages describing a Saturday morning, Saturday afternoon, Saturday evening and Sunday morning in Paris. It was found that interactions between activities in different periods of the weekend did indeed occur. The combination of shopping on both Saturday morning and Saturday afternoon was evaluated negatively for example, whereas shopping in itself was evaluated positively as a weekend activity. It was also observed that evening activities did not interact with daytime activities, so that it was concluded that choices on evening activities were made relatively independently of choices for daytime activities. The tests for possible differences between choices in different stages of the activity pattern showed that in this case study respondents did not evaluate activities differently depending on the period of the weekend.

Significant differences were observed between the choices for combined activity pattern packages for all periods of the weekend and for choices related to different stages of the activity pattern. For two of the four stages (Saturday morning and Saturday afternoon) scale differences could explain the observed differences in parameter values. For the other two stages (Saturday evening and Sunday morning), however, separate models were required.

Examples of services and services environments where the proposed models of consumer activity pattern choices could be of potential benefit include services such as retailing, tourism and recreation, cultural and sports events and service environments such as shopping malls, theme parks, cultural heritage sites, museums and sports complexes.
The consequences of our present findings are relevant to marketing managers in these retail and services areas for several reasons. First, it has been shown that consumer choices of activities are interdependent. This implies that the impact of marketing actions to promote services can potentially be increased by promoting attractive packages of services rather than promoting each service separately. Secondly, it has been shown that consumers’ evaluations may change in different stages of the activity pattern. This provides support for the argument to use different marketing strategies for different stages of the activity pattern choice. For example, consumers coming to a shopping mall planning to undertake certain activities in the mall may change their preference for activities once they have undertaken some activities in their activity pattern. Consequently, marketing strategies of retailers to draw consumers to a mall may need to stress different benefits than marketing strategies that aim to make consumers undertake certain activities in the mall.

In future research we hope to extend our application of the proposed design approach to measure consumer preference in different sequential stages of activity pattern choices. This will involve a model and experimental design approach where all future activities in the activity pattern will be varied for each of the choice stages. This would further extend the more controlled approach presented in this study. Also, we hope to address the issue of measuring consumers’ preferences for attributes of activity patterns that may be interdependent, such as activity durations of subsequent activities given a limited time budget, or the choice of a location given that another location is already being visited.

References