# Destination and mode choice for skiing trips within Switzerland

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**Arbeitsbericht** **127**
**Verkehrs- und Raumplanung** **July 2002**

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Juli 2002

## Kurzfassung

Die Ziel- und Verkehrsmittelwahl beim Skifahren sind der Inhalt dieses Arbeit. Im Mittelpunkt des Interesses stehen insbesondere die Variablen, die für diese Wahlen verantwortlich sind. Für diesen Zweck werden Modelle entwickelt.

Die Modelle stützen sich auf drei Pfeiler. Eine detaillierte Datenbasis für alle Schweizer Gemeinden und Informationen über die Verkehrssituation bilden den ersten Pfeiler, nationale Nachfragedaten den zweiten. Zudem ist eine geeignete Methode notwendig. Da die Ziel- und Verkehrsmittelwahl diskrete Entscheidungen, die auf verschiedenen Ebenen anfallen, sind, kommen *Nested Logit* Modelle zum Einsatz.

Die Modellergebnisse zeigen, dass die Fahrzeiten zwischen Quelle und Ziel sowie Variablen, die die Gemeinde und ihre Lage beschreiben, die Entscheidung am stärksten beeinflussen. Die Skiinfrastruktur an sich spielt eine untergeordnete Rolle

## Schlagworte

Skifahren; Zielwahl; Verkehrsmittelwahl; Nested Logit Modelle; Freizeitverkehr; ETH Zürich; Institut für Verkehrsplanung und Transporttechnik, Strassen- und Eisenbahnbau (IVT)

## Zitiervorschlag

Simma, A. und K.W. Axhausen (2002) Destination and mode choice for skiing trips within Switzerland, *Arbeitsberichte Verkehrs- und Raumplanung*, **127**, Institut für Verkehrsplanung und Transporttechnik, Strassen- und Eisenbahnbau, ETH Zürich, Zürich.

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## Abstract

Destination and mode choice for skiing trips within Switzerland are the focus of this paper. Especially, the factors responsible for these choices are of interest. For this purpose models are developed.

The models are based on three pillars. A detailed database for all Swiss municipalities and information about the travel situation form the first pillar, nation wide demand data the second pillar. Additionally a suitable method is necessary. Because destination and mode choice are choices between discrete alternatives at different levels, *Nested Logit* models are used.

The model results show that the travel times between origin and destination and variables describing the municipality and its location mostly influence the decision. The direct skiing infrastructure is less important.

## Keywords

Destination choice; mode choice; leisure travel; nested logits; skiing trips; ETH Zürich; Institut für Verkehrsplanung und Transporttechnik, Strassen- und Eisenbahnbau (IVT)

## Preferred citation

Simma, A. and K.W. Axhausen (2002) Destination and mode choice for skiing trips within Switzerland, *Arbeitsberichte Verkehrs- und Raumplanung*, **127**, Institut für Verkehrsplanung und Transporttechnik, Strassen- und Eisenbahnbau, ETH Zürich, Zürich.

# 1. Introduction

Leisure is the most important trip purpose in Switzerland. In 2000 44% of all person kilometres respectively 40% of all trips were made for the purpose leisure. 40% of these leisure trips respectively 70% of the person kilometres for this purpose were made by private car. Public transport plays rather a subordinate role. Only 8% of the leisure trips were made by public transport. The share of public transport on the person kilometres is a little bit higher, indicating that public transport is used for comparatively long trips (Bundesamt für Raumentwicklung and Bundesamt für Statistik, 2001). Therefore leisure traffic is a major contributor to the well known negative effects of motorised traffic.

To analyse leisure traffic is not only interesting because of its volume, but also because of an other special feature. Leisure traffic is very heterogeneous. Firstly, because different types of activities are designated as leisure. 'Going out' (22% of all leisure trips), 'excursions not including sports' (20% of all leisure trips) and 'visits to friends and acquaintances' (18% of all leisure trips), are the most often mentioned activities. Sport activities are responsible for 10% of the leisure trips (Bundesamt für Raumentwicklung and Bundesamt für Statistik, 2001). Secondly, because leisure trips are generally characterised by less rigid constraints than for example work or school trips. Often the time, the destination, the duration and the kind of activity can be chosen relatively independently.

In contrast to the significant contributions of leisure traffic to overall traffic, leisure traffic has received relatively little attention in travel modelling practice - mostly because of its heterogeneity and consequently the problems connected with analysing leisure trips. However, some recent studies have underscored the need to model leisure trips more systematically and to recognise the behavioural differences underlying travel decisions for different types of leisure trips (Bhat, 1998; Pozsgay and Bhat, 2001; Lanzendorf, 2001).

The aim of this paper is to contribute towards this growing literature on leisure travel. It especially focuses on destination and mode choice within Switzerland for a specific leisure activity - namely skiing. Skiing was used because of two reasons. On the one hand, skiing is one of the most important sportive leisure activities in Switzerland. According to Brandner, Hirsch, Meier-Dallach, Sauvain and Stalder (1995) it is performed by approximately 20% of all Swiss at least once a year. On the other hand, it is relatively easy to describe the quality of a skiing resort (Gottardi, 1980). Other activity types have been treated in another paper of the authors (Simma, Schlich and Axhausen, 2002).

The remainder of this paper is structured as follows: This foreword is followed by an introduction to the theory of the method used - *discrete choice modelling*. Discrete choice modelling is used here, because destination as well as mode choice are choices between discrete alternatives. The next section presents very briefly the data base used. Then the different steps during the development and specification of the model are presented. The fifth section shows the empirical results and an interpretation of them. The final section summarises the findings from the models and discusses the relevance of these findings.

# 2. Discrete choice modelling

Already in everyday life people are confronted with a variety of situations where decisions and consequently decision finding processes are necessary. The decision finding process includes several steps (Laager, 1978), which are not always executed consciously. In the first place, the problem respectively the decision goal is defined. Additionally general conditions and criteria for reaching the goal are set up. Then the situation is analysed resulting in set of alternatives, whereby different consequences are connected with each alternative. These consequences are assessed so that there is an order of precedence between the alternatives. The decision is based on this order of precedence.

An example for an everyday decision situation is participation in traffic. It always forces persons to choose one alternative out of a set of alternatives which exclude each other mutually. Travellers have to choose - among other things - the means of transport, the departure time, the destination and the route. Mostly these decisions are made simultaneously and are determined by long-term decisions, like car availability, season-ticket-ownership or the living environment. Qualitative choices out of a set of distinct and non divisible alternatives can be modelled using *discrete choice modelling*.

## 2.1 Basics

Discrete choice models are based on the assumption, that persons are trying to maximise the utility of their performed activities and therefore choose that alternative out of all possible alternatives which is likely to offer them the highest utility. Although it is obvious that this assumption is an oversimplification of human behaviour, models based on this assumption obtain results which are much more realistic than models based on gravitation or entropy theory (Arentze, Timmermans, Hofman and Kalfs, 1997). A more detailed description of discrete choice models can be found in Ben-Akiva and Lerman (1985), Maier and Weiss (1990) or Ortúzar and Willumsen (1994); the basic ideas were developed by McFadden (1973).

There exist different types of discrete choice models. All of them share the assumption, that out of a set of alternatives each person *q* expects a different utility (*U*). Each alternative *j* can be described by different characteristics *x*, whose values vary across different alternatives. Each utility depends on the different judgements of those characteristics. The judgements can at least partially be derived from different personal factors *p*, for example gender or age. Additionally the evaluation of the utility of an alternative depends on the situational factors *s*, for example the weather conditions or the travel time, which vary between different persons and alternatives.

As it is neither possible to know all relevant characteristics or choice alternatives nor to measure them exactly, the judgement is composed out of a deterministic and a (at least from the analyst's point of view) stochastic part. The total utility can therefore be calculated as:

$$U_{jq} = V_{jq} + e_{jq} \qquad (1)$$

with $V_{jq}$ as systematic and measurable part which describes the objective utility of alternative *j* for person *q* and the random error $\varepsilon_{jq}$, which modifies $V_{jq}$ with regard to the individual judgements of a decision maker and possible errors in observation or measurement. The systematic utility is a function of characteristics describing the alternative, the individuals and the situation:

$$V(X_{kjq}) = \alpha_j + \sum \beta_{k''j}\, p_{k''q} + \sum \beta_{k'j}\, s_{k'q} + \sum \beta_{kj}\, x_{kjq} \qquad (2)$$

The stochastic part of the utility function depends on the assumption about its distribution, which is at the same time the distinguishing mark between the different model types. The most simple and according to Maier and Weiss (1989) most commonly used version of discrete choice modelling is the *Multinominal Logit* (MNL), which is based on the assumption that $\varepsilon_{jq}$ is *independent and identically gumbel distributed* (Ben-Akiva and Lerman, 1985). This so-called IIA-assumption (independence of irrelevant alternatives) implies some constraints on the application of the model which can be released in other model types. The linear utility function represents a further model restriction.

## 2.2 Nested logit model

The most often used improvement of the MNL is according to Koppelmann and Wen (1998) the *Nested Logit Model* (NL) - sometimes also called *Tree Logit* or *Hierarchical Logit*. McFadden (1978) proved that the NL is a special case of the *Generalised Extreme Value Model*. The development of the model is presented in Ortúzar (2001), while a discussion about its derivation and theoretical basis can be seen in Koppelmann and Wen (1998), Daly (2001) or Koppelmann, Sethi and Wen (2001).

The main difference between the NL and the MNL is, that in the NL correlations between the random errors of alternatives within different groups ('nests') may exist. These unobserved factors influence all alternatives within a nest identically. The error terms between two nests are uncorrelated. The different nest levels represent decisions. Although the decisions are contextual connected, this does not mean that they are serially dependent and that there is a hierarchy in the process. Instead all steps of the decisions are performed simultaneously (Urban, 1993).

The choice probability of each alternative can be calculated according to equation (4) as the product from the probabilities of this alternatives within this nest and the probability of the choice of the nest out of all nests:

$$P_{jq,B_k} = P_{jq|B_k} \bullet P_{B_k} \qquad (4)$$

*with*:

$$P_{jq|B_k} = \frac{e^{Y_{jq}}}{\sum_{i \in B_k} e^{Y_{iq}}} \qquad P_{B_k} = \frac{e^{W_{B_k} + \lambda_k I_k}}{\sum_{l \in k} e^{W_{B_l} + \lambda_l I_l}}$$

$$I_k = \ln \sum_{i \in B_k} e^{Y_{iq}} \qquad \lambda_k \in [0, 1]$$

To calculate the parameter β the maximum likelihood method is used.

# 3. Data base

The aim of this paper is to estimate models describing destination and mode choice for skiing trips within Switzerland. Destination choice is dependent on the characteristics of the alternatives, whereas mode choice is dependent on the characteristics of the connection between origin and destination. Both choices are also influenced by the characteristics of the travellers. Therefore, it is necessary to have information about the demand side, the supply side and the connections for the whole investigated area.

## 3.1 Supply side

A detailed data set at the municipal level was produced to describe the destinations and their supply (Simma, Hauri and Schlich, 2002). The municipal level was chosen as investigation level, because it is the lowest level at which information for a whole nation can be collected. The data set contains detailed information about the residents, the supply in the leisure and tourist sector, the tourist demand as well as the allocation of the space to different usages (*Arealstatistik*) - including even information about different vegetation types, for example open and closed forests or vines (Bundesamt für Statistik, 1997).

There is a problem inherent in this investigation level. The travellers respectively visitors think in destination units rather than in municipal units. Sometimes this unit is much smaller than a municipality. The consideration of such small destinations would create an enormous number of different alternatives which would make the modelling process very difficult. At the same time, different municipalities are sometimes viewed as one destination. Especially for skiing holidays it is often the case that people visit a complete valley or ski region rather than a municipality. However, the municipality level is a compromise between these different requests.

## 3.2 Demand side

A nation wide analysis of destination and mode choice requires demand information for the same area. In Switzerland several nation wide travel surveys exist – of those the *KEP* ('Kontinuierliche Erhebung zum Personenverkehr'), the *Zusatzmodul Reiseverhalten* and the *Mikrozensus Verkehr* were available and appropriate. These surveys were adapted as much as possible and then pooled for this analysis.

- **KEP** (SBB CFF - Direktion Personenverkehr, 1996): The SBB (Swiss Federal Railways) are responsible for the KEP, which covers the travel behaviour of Swiss adults. During one year about 17'000 persons are interviewed. The KEP has been conducted yearly since the 80ies, but the destinations of car trips have only been coded in the last two years. Therefore just the survey years 2000 and 2001, which already includes about 120'000 trips, are used.

Information about the personal situation of the travellers and about their trips over three kilometres distance during the last week is collected. For each trip the destination is known except for trips abroad which are just coded as destination outside Switzerland. Attention should be paid to the fact, that for public transport trips the railway station is assumed to be the final destination.

- **Mikrozensus Verkehr 1994, 2000** (Bundesamt für Raumentwicklung and Bundesamt für Statistik, 2001): The ARE (Swiss federal office for the spatial development) and the BfS (Swiss federal statistical office) released this nation wide survey in 1994 and 2000. In 2000 it was the sixth time since 1974. In 1994 and 2000 CATI-interviews and one day trip diaries were used to get the information. The reporting period was the whole year. 1n 1994 nearly 20'000 persons reported their behaviour, in 2000 nearly 30'000 persons.

- **Zusatzmodul Reiseverhalten** (Bundesamt für Statistik, 1999): This survey was conducted by the BfS (Swiss federal statistical office) within the context of the Swiss income and consumption census in 1998. Therefore not only the trip characteristics and the typical person variables are available, but also information about a variety of other interesting variables, for example the living situation or the purchase of expensive consumer goods.

  Approximately 10'000 persons reported over 7'000 excursions within the last two weeks. Additionally they reported holiday trips within the last 6 months and trips with up to three overnight stays within the last three months. Unfortunately only the destinations of the excursions are known.

The demand data are not only used to describe the travellers, but also to restrict the data set. It was assumed that skiing trips were only carried out in the winter months (December, January, February, March), whereby only a defined subset of alternatives was allowed as destination. A further restriction refers to the kind of trip. Different leisure trip purposes were asked in the KEP, but only the categories 'excursion' and 'holiday' were considered in the following analyses.

Table 1 Overview of the used surveys

| | KEP | MZ Verkehr 1994 | MZ Verkehr 2000 | Zusatzmodul Reiseverhalten |
|---|---|---|---|---|
| Year | 2000, 2001 | 1994 | 2000 | 1998 |
| Length of diary | 7 days | 1 day | 1 day | 2 weeks |
| Content of diary | trips over 3 km | all trips | all trips | excursions |
| Rough sample-size | 34'000 persons | 18'000 persons | 29'000 persons | 10'000 persons |
| Number of ... | | | | |
| ... trips | 115'607 | 57'606 | 96'866 | 7'299 |
| ... leisure trips[1] | 16'204 | 22'825 | 36'745 | 7'299 |
| ... winter leisure trips[2] | 3'994 | 7'757 | 13'856 | 1'688 |

[1] trips within Switzerland; only excursions in Zusatzmodul Reiseverhalten and KEP (also holidays)
[2] winter months: December, January, February, March

## 3.3 Connections

The travel situation is connected to each trip and changes, if a person goes to another destination (unlike the personal variables) or if different persons go to the same destination (unlike the variables describing the destination). The travel situation is heavily dependent on the chosen mode. In this investigation it is assumed that the skiing-destinations can only be reached by modes which go fast and with which luggage can be transported. Consequently, only public transport and private car are considered in the model.

The most important variable to describe the connection between an origin and a destination are travel times, whereby travel times are used as an approximation to the generalised costs. The software VISUM (© PTV AG, Karlsruhe) was used as basis for the calculation of travel times. Additional variables are useful to describe the quality of a public transport connection, for example the necessary numbers of changes.

# 4. Model estimation

Several assumptions and calculations must be made, before a model can be estimated. On the one hand the choice set must be generated. Because of the great number of possible alternatives - each municipality with skiing possibilities can be regarded as alternative - this step is not trivial. A further problem is that the true choice set of travellers is normally unknown to the analysts, as only the chosen alternative can be observed (Swait, 2001). On the other hand the variables used in the models must be selected. Here theoretical considerations and the availability of variables are decisive.

## 4.1 Choice set

Modelling destination choice at the municipal level has to deal with the problem that a large number of alternatives is conceivable. One possibility to cope with this situation is to draw a subset of alternatives from the universal choice set for each trip. If the error terms are identically and independently distributed, this procedure is acceptable (McFadden, 1978). Ben Akiva, Gunn and Silman (1985) presented several methods how a subset can be drawn. The simplest approach which was adopted for example by Pozsgay and Bhat (2002) is to add a random sample of non-chosen alternatives to the alternative which was indeed chosen.

This approach was also adopted here by adding nine randomly selected destinations, which were different from the chosen alternative, to the chosen alternative. It was assumed that the destination of a trip with the purpose skiing had to be a skiing resort. A municipality was regarded as skiing resort, if it had direct access to lifts. 176 municipalities fulfilled this criterion - reaching from world famous resorts, like St. Moritz, Davos or Wengen, to small resorts with only one lift for children.

Focus of this model is not only destination choice, but also the choice of a mode. Therefore it was necessary to add this second decision level and to divide each destination into two mode specific alternatives. As a result the choice set consisted of twenty different alternatives, whereby the chosen alternative is dependent on the chosen mode and the chosen destination.

## 4.2 Selection of alternative specific variables

For the activity skiing objective factors, like price level, snow conditions, accessibility or number of lifts, as well as subjective factors, like the atmosphere or the friendliness of the other guests and residents, are important (Klassen, 2001; Klenosky, Gengler and Mulvey, 1993). A study about the price level of different Swiss skiing resorts has shown, that much variability can be explained by objective factors (Berwert, Bignasca and Filippini, 1995-1996). But the ski facilities themselves are not the only attraction for the tourists. Brandner, Hirsch, Meier-Dallach, Sauvain and Stalder (1995) pointed out, that new offers for special sport segments like snowboarding, aprés-ski facilities and non-ski facilities in case of bad weather are also crucial for ski areas to attract tourists.

Most of these objective variables are in the data set, whereby height is used as indicator of the probability of good snow conditions (see Table 2). Additionally variables describing the subjective quality of the resort were added. These variables are based on a five point scale concerning the quality of skiing facilities, the quality of snowboard facilities, the quality of cross-country ski facilities and the quality of aprés-ski facilities (ADAC, 2001). The situation in Switzerland (different languages and cultures in one state) and the fact, that sometimes a whole area rather than one municipality is considered, suggested to use binary variables for specific areas, for example Wallis or not Wallis.

The selection of variables was not only based on theoretical considerations and the availability of variables, but also on the correlations between the variables. Because variables which are highly correlated can cause problems during the estimation process, pairs of variables with a correlation coefficient greater than 0.6 were tested in greater detail. The variable pairs 'Quality of skiing facilities' and 'length of tracks' respectively 'quality of après-ski facilities' and 'number of guest beds' are examples for highly correlated relationships. Mostly the inclusion of both variables in one model was avoided.

Table 2 Descriptive statistics of the variables for the skiing model

| | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| Height of municipality [m] | 1’118 | 351 | 397 | 1'904 |
| Number of inhabitants [n] | 1'762 | 2'780 | 31 | 30'800 |
| Population density [n/ha] | 22.0 | 10.0 | 4.2 | 61.7 |
| German speaking | 0.53 | 0.50 | 0 | 1 |
| Wallis | 0.40 | 0.49 | 0 | 1 |
| Area with forest [ha] | 828 | 751 | 16 | 3'792 |
| Unvegetated or unproductive area [ha] | 2'093 | 3'469 | 0 | 20'640 |
| Number of ice skating facilities [n] | 0.76 | 1.26 | 0 | 6 |
| Number of public indoor pools [n] | 0.80 | 1.47 | 0 | 9 |
| Number of indoor tennis courts [n] | 0.14 | 0.34 | 0 | 1 |
| Price for a daily ticket [SFr] | 47 | 11 | 0 | 75 |
| Number of lifts [n] | 6 | 8 | 0 | 44 |
| Length of tracks [km] | 144 | 136 | 1 | 650 |
| Price *10 / length of tracks | 9 | 17 | 0 | 217 |
| Quality of skiing facilities | 3.37 | 1.00 | 2 | 5 |
| Quality of snowboard facilities | 3.21 | 1.20 | 0 | 5 |
| Quality of cross-country skiing facilities | 2.70 | 1.11 | 1 | 5 |
| Quality of hiking facilities | 2.84 | 1.30 | 1 | 5 |
| Quality of après-ski facilities | 3.10 | 0.91 | 1 | 5 |
| Number of second homes [n] | 644 | 792 | 20 | 5'157 |
| Number of guest beds [n] | 1'457 | 2'237 | 4 | 15'958 |
| Beds in parahotellerie / all beds [%] | 61 | 35 | 0 | 100 |
| Expensive hotel beds / all hotel beds [%] | 2 | 8 | 0 | 56 |
| Nights per hotel bed [n] | 104 | 85 | 0 | 501 |

## 4.3 Selection of personal variables

The participation in a special activity is the result of humans trying to satisfy their needs and maximise the utility of their behaviour. But the behaviour is limited due to different constraints. These constraints can be distinguished for leisure activities in intrapersonal and structural constraints (Crawford, Jackson and Godbey, 1991). The intrapersonal constraints include personal skills and abilities, while the structural constraints include spatial, temporal or financial constraints. Gilbert and Hudson (2000) certified this theory for skiing participation and showed that the intrapersonal constraints are responsible for the question if a person goes skiing at all, while the structural constraints are more important for the choice of a destination.

Temporal and spatial constraints depend to a large extend on different socio-demographic factors. The variables age, gender, employment status, time budget, car-availability, income, number and age of children were found to be important for leisure travel (Lu and Pas, 1999; Zängler, 2000; Lücking and Meyrat-Schlee, 1994). Additionally, different studies – either based on empirical findings or on theoretical considerations – pointed out that the living situation (Fuhrer and Kaiser, 1994), general values and preferences (Götz, Jahn and Schultz, 1997), the social context and friends (Blinde and Schlich, 2002), previous journeys (Oppermann, 1991) and the level of information of travellers (Klassen, 2000) also influence travel behaviour. Unfortunately, only the variables 'age', 'gender', 'employment', 'number of household members' and 'number of cars' are available in all surveys used.

## 4.4 Selection of variables describing the travel situation

The travel times for private car were calculated straightforward with the software VISUM (see Table 3). To calculate the travel times for public transport was more complicated, because VISUM only contained the travel times between railway stations. As the travel times between municipalities were needed, several additional steps were made.

First, it was necessary to assign each municipality to the nearest railway station. An additional file of VISUM included this information. If a municipality was assigned to more than one railway station, the more relevant railway station was selected. Then the travel times from the respective municipality to the municipality with the nearest railway station were calculated. These travel times were based on the travel times by car - multiplied by 1.5.

Second, the access times from the railway station to the actual destination respectively the actual origin were enclosed. For the municipalities with railway stations it was possible to use GIS-based calculations. For the other municipalities an average access time - 5 minutes - was used. The travel times are not sufficient to describe the quality of a public transport connection. Additionally the number of changes, which were also available in VISUM, was considered. The calculation of the number of changes in VISUM is based on the average number of changes for a connection during a day.

Table 3 Descriptive statistics of variables describing the travel situation (all municipalities)

| | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| Travel time by public transport [min] | 197 | 89 | 1 | 580 |
| Travel time by car [min] | 130 | 67 | 1 | 440 |
| Distance [km] | 182 | 101 | 1 | 592 |
| Number of changes (only railway) [n] | 2 | 1 | 0 | 7 |
| Railway station at destination | 0.10 | 0.31 | 0 | 1 |

# 5. Model results

Based on the theory and the preparations steps models can be estimated. Firstly, a MNL model was developed, which is described in detail in another paper of the authors (see Simma, Schlich and Axhausen, 2002). In this MNL only the choice of the destination was analysed. The respective model results gave hints on the possible structure of the NL and were used as basis. By using NL it was possible to add mode choice to the choice of a destination. The first estimations of both model types were modified according to the model results, whereby any modification was based on prior understanding and was not guided by the model results alone.

## 5.1 MNL-Model

Starting point of the estimation process was a model including most of the mentioned spatial variables, the travel distances between origin and destination as well as variables describing the person, which were used in conjunction with generic variables. The first attempts already showed some interesting results. On the one hand, the person variables had very low influence on the model results. So all of them had to be omitted. On the other hand the great importance of the distance variable became visible. So it seemed useful to estimate models with and without this variable.

The final model consisted of a variety of different variables and had a high quality, whereby the fit of the model with the distance variable was much higher than the fit of the other model. The distance between origin and destination was able to explain 40% of the model's variability. This means, that destinations further away are less interesting than nearby skiing resorts.

The choice of a destination was additionally influenced by variables describing the quality of the skiing resort and by variables exceeding the traditional skiing supply. Especially the availability of a public indoor pool and après-ski facilities increased the attractiveness of a municipality.

## 5.2 NL-Model

Based on the results of the MNL a NL was developed. Once again ten destinations - one chosen and nine randomly selected non-chosen alternatives - were used. Each destination was divided into two modes, which now could be described in more detail. The basis model consisted of two equation systems, one describing the choice of a destination, one describing the choice of a mode.

- **Equation for destination choice**: This equation included a variety of spatial variables. The range of spatial variables changed from model step to model step. Variables with no significant influence were omitted or at a later stage once again considered, other variables were transformed. Table 4 gives a simplified overview of these modification process. The changes according destination choice had little influence on the model fit.

- **Equation system for mode choice**: For each mode an own equation was defined. The equation for car included the travel times between origin and destination and the personal variables 'age', 'number of cars', 'employed' and 'male', whereas the equation for public transport included the travel times, the average number of changes and the fact, whether there is a railway station at the destination or not.

Beside the structure of the tree and the equations, the inclusive value parameters have to be specified. After several attempts it was decided to equalise them.

Table 4 Simplified overview of the modification process (spatial variables at destination)

| | Step 1 | Step 2 | Step 3 | Step 4 |
|---|---|---|---|---|
| Height of municipality [m] | x | X | x | x |
| Number of inhabitants [n] | x | X | | |
| Population density [n/ha] | x | | x | x |
| Change of language region | x | | x | x |
| Wallis | x | X | | x |
| Area with forest [ha] | x | | | |
| Unvegetated or unproductive area [ha] | x | | | |
| Number of ice skating facilities [n] | x | | x | |
| Number of public indoor pools [n] | | x | | x |
| Number of indoor tennis courts [n] | | | x | |
| Log (price for a daily ticket) | x | | x | x |
| Number of lifts [n] | x | x | | |
| Length of tracks [km] | | x | x | |
| Price *10 / length of tracks | x | x | | |
| Quality of skiing facilities | x | | | |
| Quality of boarding facilities | | x | | |
| Quality of cross country skiing facilities | x | | | |
| Quality of hiking facilities | | x | x | x |
| Quality of après-ski facilities | x | x | x | x |
| Number of second homes [n] | x | | x | x |
| Number of guest beds [n] | x | x | | x |
| Beds in parahotellerie / all beds [%] | x | x | | |
| Expensive hotel beds / all hotel beds [%] | x | | | |
| Nights per hotel bed [n] | | x | x | x |

The results of the final model are presented in Table 5. The table shows the estimates for the coefficients, the respective t-statistics and their significance (P[|Z|>z]) as well as the model fit. The inclusive value parameters are not included, because the all have the same value - namely 1.835. Additionally, the elasticities for the travel times were calculated (see Table 6), whereby the results for the chosen destination are in the table.

Table 5 Coefficients, t-statistics, their significance and model fit of the skiing model

| | Coefficient | t-statistics | Significance |
|---|---|---|---|
| Travel time by car | -0.015 | -6.536 | 0.000 |
| Travel time by public transport | -0.007 | -4.000 | 0.000 |
| Railway station at destination | 1.152 | 7.676 | 0.000 |
| Number of changes | -0.078 | -1.285 | 0.199 |
| Age | 0.480 | 1.403 | 0.161 |
| Number of cars | 0.803 | 7.306 | 0.000 |
| Employed | 0.694 | 4.615 | 0.000 |
| Male | 0.599 | 3.885 | 0.000 |
| Height of municipality | 0.001 | 7.343 | 0.000 |
| Population density | 0.015 | 2.755 | 0.006 |
| Change of language region | -0.665 | -4.434 | 0.000 |
| Wallis | 0.651 | 4.218 | 0.000 |
| Number of public indoor pools | 0.210 | 7.861 | 0.000 |
| Log (price for a daily ticket) | 0.155 | 0.897 | 0.370 |
| Quality of hiking facilities | -0.057 | -1.330 | 0.184 |
| Quality of après-ski facilities | 0.102 | 1.508 | 0.132 |
| Number of second homes | 0.000 | 1.690 | 0.091 |
| Number of guest beds | 0.000 | 2.334 | 0.196 |
| Nights per hotel bed | 0.003 | 4.606 | 0.000 |
| Sample size (trips) | | | 906 |
| Log likelihood function ($\beta$) | | | -1'697 |
| $\rho^2$ | | | 0.375 |

Table 6 Elasticities for travel times (chosen alternative)

| | Branch | Choice | Total effect |
|---|---|---|---|
| Travel times by car | | | |
| Car | -0.242 | -0.095 | -0.337 |
| Public transport | -0.077 | 0.095 | 0.018 |
| Travel times by public transport | | | |
| Car | -0.034 | 0.043 | 0.008 |
| Public transport | -0.028 | -0.043 | -0.070 |

## 5.3 Interpretation

Nearly all of the variables describing mode choice are highly significant. The travel times by car as well as the travel times by public transport influence the choice of a destination negatively - indicating that travellers prefer short journeys. Beside short journeys travellers appreciate a railway station at the destination. The variables describing the person also show circumstances which enhance the possibility of an alternative to be chosen. Being male and employed as well as possessing cars have positive effects on the choice.

The variables describing the destinations can be divided more or less into two groups. On the one hand, there are variables, which are directly connected with the quality of the skiing infrastructure - for example the quality variables developed by the ADAC. Only one of these variables is in the final model - the price for a daily ticket, but even this variable is not significant. The variable was kept in the model to make this fact clear. It is unclear, if the variable height belongs to the skiing infrastructure (as an indicator for the snow conditions) or if it belongs directly to the destination and its location within Switzerland. In any case - this variables is highly significant and has a positive effect on the choice of a destination.

On the other hand, there are variables which describe the destination more exactly. Apart from two exceptions all of these spatial variables positively influence the choice of an alternative - meaning that an increase of one of these variables is attractive for travellers. Important for the choice are three different type of variables:

- Destination specific variables, like the population density
- Variables describing the tourist offer and its usage, like the number of indoor pools or the nights per bed
- Variables describing the location of the destination, like the area specific variable

# 6. Conclusion

Modelling destination choice for leisure trips is at the moment a relative undeveloped area in transport modelling and even more modelling destination choice in conjunction with mode choice. But it is necessary to make progresses in this area, because leisure travel has become the most important trip purpose and the consequences of leisure travel are far reaching. The destinations themselves, especially small municipalities in the Alps, as well as municipalities on the main routes are often dominated by leisure travel.

Modelling destination and mode choice requires suitable data sets and tools. Because the choice of a destination or a mode is a choice between discrete alternatives and because two decision levels exist, one common form of discrete choice modelling - the NL - was used here - knowing that not all particularities of these two choices can be captured and that further developments are desirable. But the results obtained give interesting hints on the relationships between the variables and the two choices, which are useful for planers and persons responsible for the supply in a municipality respectively in the transport sector.

One main result of the models was that the choice of a destination is heavily influenced by the variables describing the traffic situation. Travellers weigh the attractiveness of a destination against the impedance between their origin and a potential alternative. This means that municipalities further away from the main cities must have a very attractive supply to attract people. Against this background the wish of many municipalities to have access to the main network becomes understandable. This statement is supported by the fact that the availability of a railway station is important for the choice of an alternative.

Most leisure activities require a respective infrastructure for carrying out them. For example skiing is not conceivable without lifts and tracks. Therefore it is highly probable that a good infrastructure would be attractive for the potential users. But the model results do not prove this hypothesis. The direct skiing infrastructure is not as important as other facilities - like a public indoor pool or aprés-ski facilities - for the choice of a skiing resort. Additionally the structure and the location of the destination are important.

To sum up - the model results show the importance of a good accessibility and varied infrastructure. What do these results mean for planners and sellers of tourist services? Is the conclusion admissible that a tourism dependent municipality can only survive, if it continuously improve its supply and its access. To some extent this conclusion is right, especially because the competition between destinations is becoming fiercer.

But it should also be kept in mind that a nation wide analysis has no place for smaller innovations. For example, a municipality like Elm will never reach the visitor numbers of the world-famous St. Moritz, but it can be successful in attracting a specific type of tourists. So the results should not be understood as an excuse for further, but not well considered extensions of the tourist infrastructures. Especially, investments in the skiing infrastructure could not have the desired effects.

## 7. Acknowledgements

The authors would like to thank Milenko Vrtic for the calculation of the distances and travel times within Switzerland and Dimitri Hauri for his help building the database describing 3000 Swiss municipalities with regards to their infrastructure and attractions.

The authors are grateful to the SBB for providing us with the KEP data and to the Bundesamt für Raumentwicklung for providing us with the Mikrozensen. We want to acknowledge especially the help of Mr. Philipp Müller (SBB, Bern).

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