Chapter 6
Welfare, Benefit and Freedom of Choice

Abstract  A distinction is made between advantage and achievement. The observed entropy of a sample is used as a measure of revealed freedom of choice. A measure of welfare (advantage) is obtained by combining negative expected cost (achievement) and entropy (freedom of choice). The measure of welfare (advantage) turns out to be the so called composite cost.

6.1 Introduction

Demand for travel depends on the localization of housing and work places and other centers of activities. The network users make choices with regard to route, travel mode, origin and destination and the traffic conditions. Factors influencing the amount of travel and the way the traffic system is being used are money costs, time costs, parking costs etc. Factors such as fare policies, traffic control policies and the construction of new roads also influence the choices.

The minimum cost would be obtained if every trip maker chooses the cheapest alternative. But this is not the interesting case. Rather, the case of interest is when there is some variation in the choices. This variation can be given the interpretation of freedom of choice. Large variation means more freedom of choice. We shall show how a measure of freedom of choice can be constructed and how this freedom of choice measure can be combined with average cost to give a welfare measure or as we will call it a measure of advantage. Freedom of choice can also be called degree of choice.

We shall distinguish between two things: the advantage to the network users and the achievements of the network users. The distinction between advantage and achievement was introduced by Amartya Sen in his discussion of freedom of choice (Sen 1988).

The achievement of the network users will be measured by the negative of average cost. By using the negative of average cost as a measure of achievement of the network users the traffic planner can analyze and evaluate the effects of changes in management, control, design and the effects of investments aiming at the improvement of the performance of the system. However this is not enough, changes in
the freedom of choice has also to be taken account of. Consider, for example, the trip distribution problem treated in Sect. 5.5. The minimum average cost would be obtained if the network users (were forced to) follow a linear programming optimal solution, resulting in less freedom of choice. But this is usually far from the behavior that can be observed in practice. Hence, we need a measure of freedom of choice in order to evaluate and compare different plans for the development of the traffic system.

Freedom of choice, as we use the notion, is a property of the trip pattern obtained when the trip makers have made their choices. Freedom of choice is related to the quality of the traffic system and as such it can be used by the traffic planner to evaluate the traffic system and compare different plans for the development of the traffic system. The presumption is that the choices made by network users relate to factors such as money costs, time costs, parking costs, fare policies, traffic control policies etc. Freedom of choice is not a factor considered by the trip maker in the decision process.

We shall introduce a measure of freedom of choice in Sect. 6.4 and then in Sect. 6.5 combine this freedom of choice measure with the measure of achievement discussed above to obtain a measure of welfare or advantage, which includes the achievements. However, we shall begin by discussing freedom of choice detached from the choice mechanism; aiming at a freedom of choice measure that can be used to compare different realized trip patterns irrespective of the mechanism behind the occurrence of specific trip patterns.

In classic discrete choice theory, ARUM theory, composite utility – the so called log sum – has the interpretation of expected achieved perceived utility. In microeconomics it therefore has the interpretation of indirect utility. It is also the consumer surplus function. We shall see that our measure of advantage is equal to the composite utility, thus giving a new interpretation of this quantity.

### 6.2 Achievement Measure

We shall begin by repeating some notation. Let \( \Omega \) be the set of all decision makers. The cost of the alternatives are given by \( c_k, k = 1, \ldots, K \). Let \( p_k = \Pr(d_n = k) \) denote the probability that a decision maker drawn at random from the population \( \Omega \) chooses alternative \( k, k = 1, \ldots, K \). Let \( d = (d_1, \ldots, d_N) \) and \( z(d) = (z_1(d), \ldots, z_K(d)) \) denote the decision patterns and the frequencies respectively in a finite sample of size \( N \).

The benefit - or achievement as we shall call it - of the decision makers in a finite sample of size \( N \) is measured by the negative average cost \( \bar{c}(d) = -\frac{1}{N} \sum_{k=1}^{K} c_k z_k(d) \). Taking expected values we obtain \( E[-\bar{c}(d)] = -\sum_{k=1}^{K} c_k p_k = -c \).

In the multi attribute logit model, (5.2), we have to translate the different costs into say, units of the first cost. This is done by using the rates of substitution \( \beta_s / \beta_1 \) to obtain the generalized cost \( c_k = \sum_{s=1}^{S} (\beta_s / \beta_1) c_{sk} \) (see Sect. 5.4).