# Modeling Random Choice Behavior in the Context of the Size of the Choice Set

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***Abstract:*** **The structure and properties of the Choice set from which individuals make deterministic or random choice, has got mathematical implications on the probability of the choice and utility earned thereof. In this paper, one of the choice set properties – size of the set, is analyzed in depth and the random component of the utility model is expressed in that context. Experimental design of the hypothesized relationships is proposed in the end.**

***Key Words:*** **Choice Set, Random Choice Theory, Utility**

## I. INTRODUCTION

Individual Choice is not only governed by rational choice through utility maximization behavior but also by random choice governed by chance (Becker, 1962). The society functions as a system defined by individual decisions. These decisions in aggregate shape the direction of the economic variables under consideration. Most economic models assume that the decision maker is rational, that is, his every choice is directed towards maximization of utility. More formally, a rational preference of an individual is represented by a utility function and his choice can be conceptualized as the result of utility maximization. Although, assumptions of continuity (where preferences of individuals does not suddenly reverse) and certainty (not involving risk) apply to the said model, a random component Ɛ must be brought in to accommodate mistakes, inattentiveness etc. on the part of the respondent (Becker, 1962) and also observational error on the part of the researcher (Moscati, Tubaro, 2011). However, for the current paper the latter is overlooked. The perceived utility model becomes V = U + Ɛ. Ɛ here represents 'noise' – a random variable with zero mean.

Becker considered the choice set to comprise of bundle of goods. Immediately after Becker, another variant of the model was proposed where individuals choose goods instead of bundles (Chant, 1963). The chance of any product being chosen from the choice set is considered almost equal i.e. the random variable is assumed to follow uniform distribution. Any economic phenomenon, probabilistically called 'Event' can be explained both as a result of rational and random decisions (Alchian, 1950); rational choice implies profit maximization and random choice implies probabilistic behavior accompanied by luck.

Economists however, are surprisingly reluctant to cleanly accept the random utility models. May be the reason is that it has been typically modeled on discrete choice situations, whereas most economic models are based on rational choice from a set of alternatives (Clark, 1992, 1994). The issue has been positively addressed (Hildebrand, 1971) where his agents were considered to have random preferences; and contrastingly addressed too (McFadden, 1981) where deterministic and stochastic models are taken together in a hybrid form. It is clearly evident that in most of the economic models – classical or modern, the assumption of rationality is implicit. On these researches, Clark in his paper raises a question: When can the continuum of choice probabilities get in line with the hypothesis of random utility maximization (Clark, 1994)?

There are several influential factors that have an impact on random choice behavior. The paper tries to highlight one of the important parameter of choice, the size of the choice set. Various researches explicitly and implicitly have taken up this issue but with a lack of formalization. Parametric version of the random utility model was proposed with an infinite choice space (Resnick and Roy, 1992). In another research, multilevel nested logit model was used to narrow down from a huge number of available alternatives and was given that there is a threshold distance beyond which adding more alternatives to the choice set has negligible effect (Parsons, Hauber, 1998).

Researchers have become cautious of various design dimensions like model outcomes, preferences, model fit etc. (Deshazo & Fermo, 2002, Adamowicz, 2009). Through these design experiments it was fundamentally recommended that cognitive burden must be reduced on respondents by reducing the number of attributes or number of alternatives in the choice set (Caussade et al. 2005). Although it was hypothesized that choice format effect disappear when random utility model allows for context-dependent preferences (Zang, Adamowicz, 2011), we need to analyze more formally the actual relation between size of choice set and random behavior.

## II. THE INITIAL FRAMEWORK

To begin with, let us consider the perceived utility model: $V_j = U_j + \varepsilon_j$, $U_j$ being the utility from the jth alternative and epsilon being the error term (the stochastic component of the

model). We assume that utility in turn is a function of $W_j$, a vector of attributes including price of alternative j. The equation now becomes: $V_j = \Delta(W_j) + \varepsilon_j$, where $\Delta$ represents a deterministic function of W.

We shall consider a non-linear quadratic utility model for this purpose assuming that consumer first want to meet minimum survival requirements and then decide to allocate their income freely in available alternatives (Deaton, Muellbauer, 1980). We further assume that the random term is not influenced by policy interventions, because if policy intervenes the initial error term may be different from final error term (Heckman et al. 1990, Mc. Fadden, 1999, Carniro, Hansen, Heckman, 2001).

The error term, is the stochastic component of the model which is hypothesized to be influenced by the size of the choice set in the following manner:

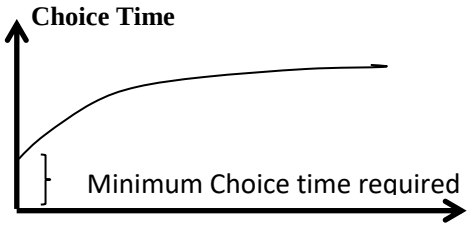
i. If the size of the choice set increases, the time to narrow down on the final choice also increases. The respondent may go through more number of stages before narrowing down or evaluation may take higher processing time if all the alternatives are considered at the same time.
ii. If the size of the choice set of a homogeneous product increases, another dimension comes in: time to encounter the alternative. Alternatives with lower time to encounter have higher probability of getting chosen.
iii. If there are n elements in the choice set and any one of them maximizes utility, then the probability that an individual will choose that one element randomly is 1/n. As 'n' becomes large the chance of the choice becomes small.
iv. If the choice set increases, the degree of randomness increases as well. The respondent compromises with maximization of utility as he perceives the time and effort to nullify the effect of higher utility. However, (Levav et al. 2012) considers decision makers as sticky adapters, but this generally holds in case of high end products where the importance attached to the product surpasses the utility thereof. Research has shown that product importance has a positive impact on choice set size (Gruca, 1989)

With the above structures let us now model the random component as a function not necessarily following uniform distribution as proposed by earlier theoreticians.

## III. THE MODEL

The model predicting the random component is divided into two constructs:

**Construct 1:** Choice time (CT) is directly proportional to the Size of Choice Set (N). $CT \propto N$, but beyond a specific threshold, the impact is negligible.

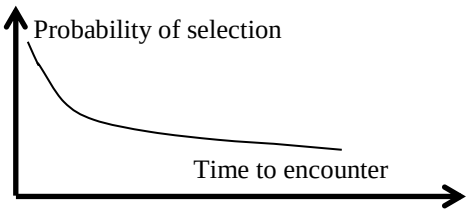



**Choice set size**

The function will be: $CT = \alpha + 1 - e^{-n/\beta}$ where $\alpha$ is the minimum choice time required, n is the number of alternatives available and β is the distribution parameter greater than 0.

As per the fourth hypothesis, the degree of randomness increases as the choice time increases. Hence, $\varepsilon = \phi$ (CT) where $\phi$ is a stochastic function.

**Construct 2:** if the respondent is aware of the product homogeneity, the products with higher chance of getting encountered has higher chance of getting selected.




Probability (P) of the jth item follows negative exponential distribution and is given as:

$P_j = 1 - e^{-\theta t}$, Where θ again is the distribution parameter.

As the respondent compromises on the utility aspect and avoids devoting more time in choosing, the perceived utility gets directly affected. If time spent is accounted for in monetary terms, then the actual consumer spending becomes Price + time value. As per consumer surplus model, the consumer will keep on searching till his perceived utility exceeds the price plus the time value. Beyond that will be random choice. So if the choice set is bigger, then the chance of the utility maximizing item remaining outside the encountered set is higher.

## IV. EXPERIMENTAL DESIGN

While choosing an alternative two knowledge aspects are considered: Subjective and Objective (Moorman et al. 2004). Both set of knowledge (information) are defined as two factors in the analyses. Panel members as research subjects can be put in to the choice set up. On arriving the participants can be placed in front of choice set. Objective criteria were taken as responses on a predefined structured questionnaire. Once the choice and responses are completed they are

objectively graded.

The subjective aspect are however taken as the random component defined previously. The data pertaining to this section can be fictitious. An upper and lower limit of price and quantity could be pre-specified but the respondents will not be told about the same before the experiment. It is to be noted that the experiment is done keeping in mind the effect of the choice set. The subjects who fall outside the allowable limits would be excluded from the experimental design.

Variables noted from the survey would be:

a. Objective knowledge weightage and factors thereof
b. Subjective weightage and implied deviations
c. Time to choice
d. Time to encounter each alternatives

Participants can be asked to make their choices without worrying about their income. No separate clues about utility maximization would be provided expect the implicit product knowledge.

The constructs drawn above can be directly substituted in the demand function and compared with the Choice probability function: $P_b$ (j, w, Y) = $\int F_j^b \{u - v_1(w_1, y), u - v_2(w_2, y) \ldots du$ (Marshallian Choice Probability function). If the values are closely approximated, then the model can be perceived to be in line with the newly developed choice model.

## V. CONCLUSION

The proposed model is subject to diligent experiments. The issues or variables that the size of the choice set is likely to have an impact are randomly chosen and modeled on perceived grounds, not empirical. This research assumes consumers to behave consistently. Future research can take into account implicit inconsistency. Furthermore, research can be conducted on modeling the risky and uncertain environment more formally.

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