ZEPPELIN UNIVERSITY

COURSE PAPER

The Influence of Indices on hypothetical purchase decisions

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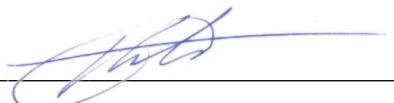
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed: 

Date: 12.05.2020

"*Where there's life, there's hope.*"(Hawking, 2018)

"*The era of procrastination, of half-measures, of soothing and baffling expedients, of delays is coming to its close. In its place we are entering a period of consequences.*"(Churchill, 2020)

"*At least, every individual must act as if the whole future of the world, of humanity itself, depends on him. Anything less is a shirking of responsibility and is itself a dehumanizing force, for anything less encourages the individual to look upon himself as a mere actor in a drama written by anonymous agents, as less than a whole person, and that is the beginning of passivity and aimlessness. "*(Weizenbaum, 1976)

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Abstract

Politics, International Relations, Public Administration

Factorial Analysis

The Influence of Indices on hypothetical purchase decisions

by Kilian LEHN

This work is about the question, which indices help the most to communicate to consumers how their potential purchase decision is related to resources and raw-materials. In economic terms: "How to render the internalisation of costs transparent to the consumer?". Therefore a general-linear-model, a multi-dimensional-scaling-analysis and a tobit model with the goal to get the strongest factors was conducted based on a survey which was developed for this purpose. Systematic variance was discovered which could help in the future to communicate to potential consumers. Furthermore a possible implementation strategy of the findings is elaborated in the end of the work.

Contents

List of Figures

List of Tables

List of Abbreviations

Cf.	**c**onfer = **V**ergleiche!
DS	**D**ata **S**et
DV	**D**ependant **V**ariable
E.g.	**E**xempli **G**ratia
IV	**I**ndependant **V**ariable
viz.	**v**idelicet = **n**amely

0.1 Manual

The reader who is comfortable with Code-Editors like R-Studio or Visual Studio Code etc. can open this document in it's .Rmd version and reproduce the computational/statistical argumentation. Execute following steps:

1. Download the raw data
2. Open the .Rmd Version

   For the density function of the dependant variable see den_200509.Rmd [1]

   For the ex-post, ex-ante frequencies of the levels/dimensions, see compile.ex.an.po_200423.Rmd[2]

   For the calculation of the indices, see animal_table_200415
3. Set the working directory path to the downloaded and extracted zip-file of the the raw data or put the .Rmd Version directly in the raw data folder
4. Proceed through the Code-Chunks (If the Editor is R-Studio, use "Show document outline")
5. Compare with the compiled version[3] in order to see if everything works and to get a feeling how the monolithic script is structured

Every coloured letter in this paper is linked, from the title page to the bibliography, so if one seeks to know more wants to know more, one has just to click on the coloured letters. If compiler issues are met please consider going to this GitHub account after the 01.06.20 in order to troubleshoot. Regarding graphics, they can be magnified if needed as they are in the PDF format.

[1] see footnote below
[2] see footnote below
[3] Packages can be shielded by one another, which leads to bizarre outcomes. However, if the reader loads the R-Chunks per se, the results should be good

Chapter 1

Pillars of the Work

1.1 Introduction

The evidence for writing this work is that there is an urge to communicate so that consumers are enabled to understand, which consequences their purchase decisions have. Because these consequences are in regard of the raw-materials consumption of some products far-reaching (cf. Mekonnen and Hoekstra, 2010). It is broadly discussed, why humans do not act in accordance with climate protective measures, "Yet, environmental awareness, is not reflected in our actions, and the environmentally harmful actions we know not to do, we tend to do anyway."(Kemp and Nielsen, 2015, Abstract). However, in this paper it is assumed that if the right fit to the perceptual space (see 2.2) of the consumer is met, the consumer is enabled to make a weighted decision of his purchase decisions. In more practical terms: Marketing research is all about selling a product or rather the need/urge to have a product. And the causality here can be easily traced, e.g: A new advertisement is online, the sales climb. However, the consumer could be educated by the advertisement or marketing in ways which have physical and, or environmental consequences which sooner or later have negative direct and, or indirect consequences for the consumer (e.g. physical/ mental health, environment, etc.) (see section 4.3 for a solution for this argument). Enterprises which openly communicate to their potential consumers that the consumer habits have an enormous impact for themselves and their surroundings (viz. *The True Cost* 2015, *The film | Demain* 2015, *COWSPIRACY* 2014), are to this day at least in the context "nutrition" (the topic of the work at hand), a rarity.

1.1.1 Alignment

For the work at hand, which is best subsumed as solution-oriented-research, the practical relevance is the basis for the theoretical relevance. As the driving course of this work isn't a theoretical relevance, the work is best characterized in the general-research-context by the help of a framework (viz. Colquitt and Zapata-Phelan, 2007, p.1283, Figure 1). The work refers to "existing conceptual arguments" (viz. Goldstone and Hendrickson, 2010) and tries the "Introduction of a new mediator" which would be here the comparison between living-resource-indices vs. non-living-resource-indices (viz. Suggested Indices). By mediator it is meant that an idea is taken up (see 1.3) and modulated in order to fit a specific purpose. In many respects this work is a synthesis of different disciplines which may be justified in the light of given circumstances (climate change (viz. Imperatives, 1987)) by the mind-set "desperate times call for desperate measures" (cf. Erasmus, 1545). The argumentation conducted in the work at hand is derived from the following disciplines:

1. Practical relevance via environmental and climate change considerations (viz. Imperatives, 1987)

2. Epistemology (viz. Watzlawick, 1976, Vollmer, 1974) and Psychological approach for the theoretical foundation and interpretation (viz. Goldstone and Hendrickson, 2010)

3. Analysis via a sociological-psychological approach called factor analysis , which is used here as semi pattern-exploratory tool (cf. Backhaus, Erichson, and Weiber, 2015). The exploratory-part being the influence of the newly introduced indices (see 2.2.1). The pattern-part being the comparison with already established indices (see 1.3).

1.2 Objective

The objective of this work is to find a set of indices which fit to the perceptual space of the mind of human beings (cf. Weiber and Mühlhaus, 2014, p. 223) of the target population (see 1.5). This depiction implies that there is some kind of ranking between fitting and less-/unfitting indices to the perceptual space of the mind of human beings (see 2.2). This is based on the the perspective, that "we believe human judgments in most areas are structured and that a critical question for social scientists is how best to uncover the structures that underlie such judgments."(Rossi and Anderson, 1982, p.16).

1.3 State of the Art

There are many kind of indices and online calculators for informing the potential consumer about the resource efficiency of his/her purchase decision. Here a short overview of the most relevant for the work at hand:

1. bbc
2. eatlowcarbon
3. foodemissions
4. foodprint

The bbc indices (henceforth referred to as Suggested Indices), were chosen in order to distinguish in the model (see Chapter 3) between already existing and used indices and the in the course of this work developed indices. The decision to take exactly those Suggested Indices as control group (= those subjects who receive no stimulus) is based on the reproducibility of the information given on the website (bbc) and the extensive research on which the calculator is based (viz. Poore and Nemecek, 2018). The distinction is concretely made between

1. non-living-resource-indices which are the Suggested Indices and
2. living resource-indices

The here scratched experimental setup is elaborated in the section 1.6.

1.4 Research Question

Have living-resource-indices a higher influence on the dependent variable (henceforth referred to as DV)"sureness of a purchase decision" than the Suggested Indices?

H_0 = null hypothesis, H_1= alternative hypothesis

1. H_0: Assuming that the tested sample lies within the confidence-interval, there is no correlation between living resource-indices and a lower "sureness of a purchase decision" than the "sureness of a purchase decision" caused by the Suggested Indices with the confidence of 0.95.

2. $H1$: With the possibility of less than 0.05 the tested sample doesn't lie within the confidence-interval, which suggests that the null hypothesis is wrong while not suggesting that the contrary is true.

$$\beta_0\chi_0 + \beta_1\chi_1 + \beta_2\chi_2 = \gamma \quad (1.1)$$

where:

1.4.1 Dimensions

γ DV: Sureness of purchase Decision
χ_0 buy groceries
χ_1 non-living resource indices
χ_2 living-resources indices

1.4.2 Levels

χ_0 Y-Axis Constant
χ_1 km/ m2/ days heating
χ_2 humans/cats/bunnies/ canaries

1.4.3 Definitions

Indices The ratio between the relative quantities of resources of some kind. The indices take the place of the independent variables (henceforth referred to as IV) in this work.

DV: Sureness of purchase Decision A feeling of the respondent if and when he/she feels sure to buy a product in the context of the hypothetical situation based on the vignette-description.

This means that if more variance is introduced by the newly suggested indices, which are described as χ_2, than by the already existing χ_1, than the H_0 that there is no correlation between living-resources and a higher uncertainty/ (lower "sureness of a purchase decision") can be rejected.

1.5 Research Steps

The reader who is acquainted with empirical works, might find it helpful to have the respective research steps clearly pointed out in a Table 1.1.

Research Step	Where to find
Convenient Sampling	Survey (2.3)
Experiment	Nature of Experiment (1.6)
Coding/Editing/Cleaning	(.Rmd Version)
Multi-Dimensional-Scaling, General linear model	(3), (.Rmd Version)
Model Approximation	(Numerical Analysis (3))

TABLE 1.1: Own depiction based on Schnell, Hill, and Esser, 1999, p. 8; see Geddes, 2003, p. 43

1.6 Nature of Experiment

The experiment conducted in this work is best described as a hybrid between an experimental and quasi-experimental design. The advantage of using a survey-vignette-design is that the Quasi-experimental design is shifted towards an experimental design. This is caused by the random treatment assignment (= randomization) of the IV. In the context of this work it means that different participants are exposed to levels of the IV (see section 3.3). To advance further in the direction of an experiment, well-defined causal states are needed. In the context of this work this would be the two groups of indices: The "living-resource indices" are the dimension (see 1.4.1) with the stimulus. The stimulus is: The aspect that the resources are recalculated in/in the Unit of living beings. The "non-living-resource indices" are the dimension without the stimulus. This gives question to if the stimulus causes variance in the overall evaluation from the respondents of the DV: "Sureness of purchase decision".

Chapter 2

Survey Design

2.1 Chapter Objective

This chapter should help to build the understanding for the reason how the survey was designed, applied and analysed. Concretely this means that the levels are deduced from the theories bespoken in the section "Perceptual Space" (see 2.2). And getting to the end of this chapter, the question is treated, how those levels and ideas were integrated in the survey.

2.2 Perceptual Space

> *"When we look at a rainbow, we tend to see about seven distinct bands of colour, even though we know from physics that the dominant wavelength of light that meets one's eye changes smoothly from the top to bottom of the rainbow. Although the rainbow presents itself to us with a continuous and full range of visible wavelengths of light, we tend to see it in terms of distinct colours such as red, yellow, blue, and violet. This effect is a striking example of categorical perception (CP). According to this phenomenon, we tend to perceive our world in terms of the categories that we have formed. Our perceptions are warped such that differences between objects that belong in different categories are accentuated, and differences between objects that fall into the same category are de-emphasized."*(Goldstone and Hendrickson, 2010, p. 69)

The example above is helpful to get a feeling of the discriminating power[1] of the categories in the human mind. It also opens up the path to a constructivist question (cf. Watzlawick, 1976), whether what the human mind perceives as the reality is more due to evolution and taught categories than to the reality itself. However, in order to make these categories measurable and interpretable in the context of this work, it needs some more explanation regarding the assumptions the survey and the analysis in the work at hand is based on. For making the assumption easily accessible, following analogy between a cloud in the sky and the perceptual space of a person: A could in the sky, out of a chemical and physical perspective consist out of molecules, particles and their interactions. Following the assumption that "theses-character of all perception of the reality; existence of a consciousness independent, structured and interlinked space, fragmentary recognisability and explainability of this interlinked space via perception, thinking and intersubjective science (hypothetical realism)" (Vollmer, 1974, p. 188), these interactions in a cloud exist and can be proofed by their consequences. In regard to the perceptual space of a person it is

[1] "[...]the degree to which an item in an attitude scale, or the scale as a whole, yields different scores when it is applied to people holding different attitudes towards the attitude object in question." (cf. *discriminating power*)

assumed in this paper, that the interactions of objects or rather the perception of the objects in a person's mind can be proofed the same way as the interactions of the molecules in a cloud, by their consequences. The consequences are in this work the responses given in the survey. The assumption just stated from Vollmer, 1974 is, furthermore the reason for measuring the DV in an interval-scaled way (from 1-101) and not in a binary way (purchase or no purchase). As not the action or non-action of the purchase is of interest here, but the "differences between objects"(Goldstone and Hendrickson, 2010, p. 69), which are hopefully brought to light by the stimuli (the levels/ the IVs). It might be interesting to note here too, that the argumentation conducted in this section so far, is the reason why object orientated programming/technology exists. The simple idea, that through the object orientation "[...] only a small semantic gap will exist between reality and the model" (Jacobson et al., 1992, p. 43) sums up this whole section and paths the way to the model inference [2]. This is also how the argumentation later on, based on the survey data, is conducted. It is avoided here to argue on the basis on hard-to-define concepts like empathy etc. but what can be stated is that "It is obvious that humans evaluate continually, and it is equally obvious that such judgements are neither totally independent nor totally idiosyncratic" (Rossi and Anderson, 1982, p. 16). Or in more drastically terms: It is not only "obvious" lake Rossi et al. just stated but it is also "an essential adaptation of perception to support categorizations that an organism needs to make." (Goldstone and Hendrickson, 2010, Abstract) as part of the evolution as "our perceptual systems become customized to the task-useful categories that we acquire, slowly at the evolutionary timescale or quickly at the timescale of individual learning." (Goldstone and Hendrickson, 2010, p. 69 and cf. Vollmer, 1974).

2.2.1 Deduction of Indices

The levels for the survey consist out of the bespoken comparison between the two dimensions of indices (see 1.6). This means that one dimensions, the "control" dimension without the living-beings, is already given by the bbc Suggested Indices. But one may ask how and why the other dimension: "living-resource-indices" were procured and based on which assumptions? The easiest answer here consists out of the process that was applied to get the living-resource-indices. A ranking of the most favourite domestic animals was the basis for the level construction[3]. Then the amount of drinking water for the one-time-purchase was calculated for two common products in German drudgery stores

1. Beef
2. Cheese

(For detailed information, please consulate "animal_table_200415.Rmd", see 0.1)
But this doesn't answer the question why exactly domestic animals and why the level: "human" was added. To answer that question we close the loop to the section Perceptual Space (2.2) and come back to the topic of Categorical perception. Levels (1.4.2) in their function as stimuli were needed that are quickly understandable and which can be brought easily before the inner eye/ easily imaginable. Furthermore it needed stable levels, which means levels which mean on average the same to the potential consumer, as it is unlikely that a concept has the same sense or meaning

[2] If the connection between programming and psychology/sociology seems arbitrary, please consult Weizenbaum, 1976, who showed the synergies between the two disciplines

[3] Duo to human error the level: "Dogs" has dropped out (see 2)

each time it is used (Barsalou, 1987, p. 101-140 and cf. Thelen and Smith, 1996). As it can be expected that every participant of the survey knows what drinking water, what domestic animals etc. are, it's highly probable, that concepts were used, which mean to everyone approximately the same concept. This is one of the statements which can be analysed by discriminating power of the levels in the survey data (see 3.3.1).

2.2.2 Sample Vignette

The survey was conducted in German, which is the reason for the graphic (2.1) of the original vignette being in German. For the readability of this paper, in the following the translation in English.

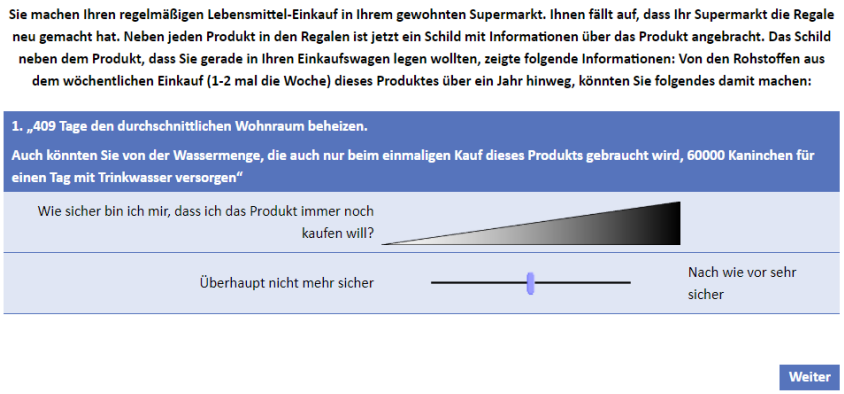


FIGURE 2.1: Sample Vignette

You make your weekly grocery shopping in the grocery-store of your choice. You notice that the grocery-shop has refurnished its shelf's. Now, beside every product an information graphic is displayed. For the product you want to purchase it reads: If you take the raw-materials from your weekly grocery shopping (1-2 times a week) of this one product across one year, you could do the following with the raw-materials: You could heat the average home for 409 days. Furthermore, from the one-time-purchase of this product you could provide drinking water for 60.000 bunnies for one day. How sure am I to still make this purchase decision?
Not at all sure any more/ Still very sure.

2.3 Survey

The sample size is 11 respondents. If the products beef and cheese are considered separately the vignette universe has 144 possible combinations. However, in the MDS analysis later on, the values of the indices/ level (if level cats has the number 60.000 or 6350) are considered as subordinate, hence in this case the universe shrinks to 12. There are in total 6 decks à 3 vignettes. The randomiser from the survey-program draws in a normally distributed manner from the 6 decks one question. If all questions are answered, the observations count 6 answers per participant, without the standard questions. The sampling method is best described as convenient sample, meaning that the participants for the survey are conveniently chosen from

the population p. This has the consequence that the target population[4] can be characterized only after the survey was conducted. The target population of this work is characterized by a mean age between 40-44, a mean income of 1500-2000€ and a mean eduction of the "Abitur", which could be expressed in English as High-School-Diploma.

[4]The target population is the population of interest

Chapter 3

Numerical Comparison

3.1 Chapter Objective

The structure for this chapter is: first the basic-descriptive observations of the survey, then the MDS-Analysis, afterwards the distribution of the DV, which leads to the topic of limited DV and the inference by the model comparison. The reason for this approach is to find the principle components for communicating with the consumer in context with his potential purchase decision. Alas the use is made of non-theoretical concepts like an ANOVA-Analysis and Multi-Dimensional-Scaling. If every step of the just described steps is conducted correctly, the results will mirror one-another. Meaning that the strongest coefficients in the glm, clustered ols model will have also the Principle-Components of the MDS-Analysis.

3.2 Recapitulation

Before jumping in the analysis, in the following a short summary of the possible outcomes of the survey-analysis: There are six scenarios for the outcome of this project:

1 living-resources-indices introduce variance (H_0 rejected)

2 non-living-resources-indices introduce variance. (H_0 not-rejected)

3 Single indicator, independent if they belong to non-living or living introduces variance (H_0 not-rejected)

4 No indicator-group and no single indicator introduces statistically significant variance. (H_0 not-rejected)

5 The amount of the values e.g "60000 Cats" etc. are important for the participant

6 The amount of the values e.g "60000 Cats" etc. are not important for the participant

3.3 Ex-Ante, Ex-Post Survey

The randomization between the different levels in the vignettes was designed pre-survey. The randomization between the different vignettes was done "on-the-flight" by the survey-program. In the graphic below, the chance for one level to be drawn from the randomiser of the survey-program is shown. It mirrors the pre-survey design (see .Rmd version).

Ex-Ante, Ex-Post Comparison

```
tbl.ex.ante = ex_ante.tbl.analy.1 %>% addmargins(2) %>% prop.table(margin=2)
tbl.ex.ante %>% round(2)*100
```

```
##                                                                      Sum Sum
## humans.beef     0  0  0 17  0 17  0  0  0  0  0  0  0  0  0  0  0  0   2   2
## cats.beef      17  0  0  0  0  0 17 17  0  0  0  0  0  0  0  0  0  0   3   3
## bunny.beef      0 17  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0   1   1
## canarie.beef    0  0  0  0 17  0  0  0 17  0  0  0  0  0  0  0  0  0   2   2
## humans.cheese   0  0  0  0  0  0  0  0  0  0  0  0 17  0 17  0  0  0   2   2
## cats.cheese     0  0  0  0  0  0  0  0  0 17  0  0  0  0  0 17 17  0   3   3
## bunny.cheese    0  0 17  0  0  0  0  0  0  0 17 17  0  0  0  0  0  0   3   3
## canarie.cheese  0  0  0  0  0  0  0  0  0  0  0  0  0 17  0  0  0 17   2   2
## heat.beef      33 33  0 33  0  0  0  0  0  0  0  0  0  0  0  0  0  0   6   6
## km.beef         0  0  0  0 33  0 33  0  0  0  0  0  0  0  0  0  0  0   4   4
## m2.beef         0  0 33  0  0 33  0 33 33  0  0  0  0  0  0  0  0  0   7   7
## heat.cheese     0  0  0  0  0  0  0  0  0 33 33  0 33  0  0  0  0  0   6   6
## km.cheese       0  0  0  0  0  0  0  0  0  0  0 33  0 33  0 33  0  0   6   6
## m2.cheese       0  0  0  0  0  0  0  0  0  0  0  0  0  0 33  0 33 33   6   6
## Sum            50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50  50  50
```

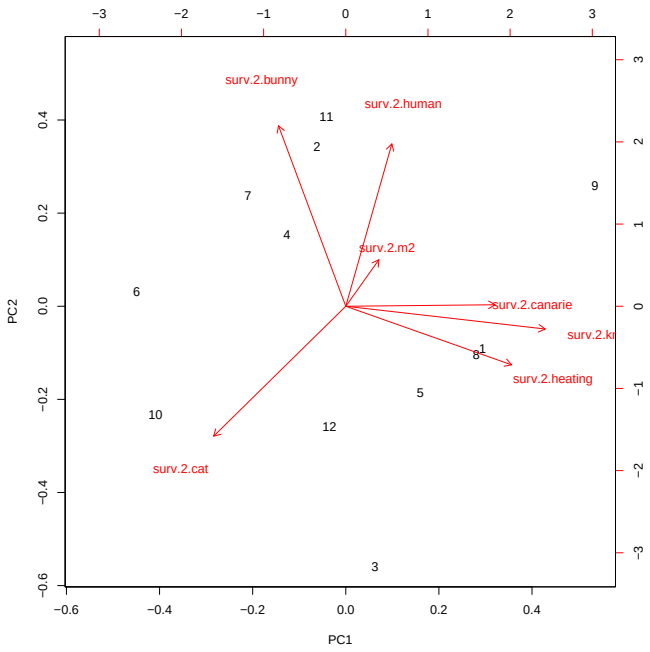
```
tbl.ex.post = ex_post.tbl.2.analy.1 %>% addmargins(2) %>% prop.table(margin=2)
tbl.ex.post %>% round(2)*100
```

```
##
## humans.beef     0 17  0  0  0  0  0 17  0  0  0  0  0 17  0  0  0  0  0 10  0
## cats.beef       0  0 17  0  0  0  0  0 17  0  0  0 17  0 17  0  0  0  0  0 17
## bunny.beef     17  0  0  0  0  0 17  0  0  0  0  0  0  0  0  0  0  0 17  0  0
## canarie.beef    0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## humans.cheese   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 17  0  0  0  0
## cats.cheese     0  0  0 17  0 17  0  0  0  0  0  0  0  0  0  0  0 17  0  0  0
## bunny.cheese    0  0  0  0  0  0  0  0  0 17  0  0  0  0  0 17  0  0  0  0  0
## canarie.cheese  0  0  0  0 10  0  0  0  0  0 17 17  0  0  0  0  0  0  0  0  0
## heat.beef       0 33  0  0 20  0  0  0  0  0  0  0 33 33  0  0  0  0  0 20  0
## km.beef         0  0  0  0  0  0 33  0 33  0  0  0  0  0  0  0  0  0  0  0  0
## m2.beef        33  0 33  0  0  0  0 33  0  0  0  0  0  0 33  0  0  0 33 20  0
## heat.cheese     0  0  0 33  0  0  0  0  0 33 33  0  0  0  0  0  0  0  0  0  0
## km.cheese       0  0  0  0 20 33  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## m2.cheese       0  0  0  0  0  0  0  0  0  0  0 33  0  0  0 33 33 33  0  0 33
## Sum            50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50
##                                                Sum Sum
## humans.beef     0  0  0  0 17  0  0  0  0  0  0   2   2
## cats.beef       0  0  0  0  0  0  0 17  0  0  0   3   3
## bunny.beef      0  0  0 17  0 17  0  0  0  0  0   2   2
## canarie.beef    0  0  0  0  0  0 17  0  0  0  0   0   0
## humans.cheese   0 17  0  0  0  0  0  0  0 17  0   2   2
## cats.cheese     0  0 17  0  0  0  0  0  0  0 17   2   2
## bunny.cheese   17  0  0  0  0  0  0  0 17  0  0   2   2
## canarie.cheese  0  0  0  0  0  0  0  0  0  0  0   2   2
## heat.beef       0  0  0  0  0 33  0  0  0  0  0   6   6
## km.beef         0 33  0  0  0  0 33 33  0  0  0   5   5
## m2.beef         0  0  0 33 33  0  0  0  0  0  0   8   8
## heat.cheese     0  0  0  0  0  0  0  0 33 33  0   5   5
## km.cheese       0  0 33  0  0  0  0  0  0  0 33   4   4
## m2.cheese      33  0  0  0  0  0  0  0  0  0  0   6   6
## Sum            50 50 50 50 50 50 50 50 50 50 50  50  50
```

FIGURE 3.1: Ex-Ante, Ex-Post Survey

3.3.1 MDS

Before proceeding to the inference part, the following mid-step is introduced: In the following analysis, the data set is manipulated. The manipulation consists out of the binding of the levels of the product cheese and the levels of the product beef. The only difference between those two products are the numbers (numbers of cats, humans, bunnies etc.). So that it is assumed for now, that the numbers play a subordinate role. This tweak was build in the survey as a low participants number for the survey was anticipated. It will be interesting to see later on, if this assumption is correct or false/ if the numbers are important for the participant or not. Regarding the question of this work, which indices have the strongest influence on the consumer perception, an multi-dimensional-scaling approach (henceforth MDS) was chosen inter alia. A MDS is fitting for the question of this work because: A higher dimensional euclidean space can be broken down in lower dimensions without loosing much information. This is based on the assumption solid bodies are related with respect to their possible dispositions as bodies in euclidean geometry of three dimensions (cf. Einstein, 1921 p.16). Or, to put it in the most practical terms: Below we can observe the collective perceptual space (like a collective brain) of a sample of the target group in the very specific context of the vignettes where no distinction is made between the product cheese and beef.



The MDS graphic above isn't only displayed here for introducing the idea of the human-mind as a higher dimensional space, which can be broken down in a MDS-Analysis, but also to answer the question, which was opened in the section 2.2.1. The question consisted of the idea that easy concepts should be used for the vignette-texts. Furthermore it was asked if these easy concepts have discriminating power in the mind of humans. One can quickly see by the length of the arrow to "surv.2.cat", "surv.2.human","surv.2.bunny" that the living-resource-indices are clearly distinguished in the perceptual space, which is modelled by the MDS above.

However, a MDS can hardly be described as a inference. Like mentioned above, this MDS-Analysis was just a mid-step before actually starting the factorial analysis.

3.4 Distribution DV

The graphic below shows the density of the DV[1], if the two products are separately treated in the data set. In other words: If we assume that the amount of humans or bunnies or cats play indeed a role in how the levels are perceived. In the distribution of the DV following things can be noted:

1. Mean: 19.875
2. Median: 15.5
3. Heteroscedastic: Skewed: 0.62, to the right (positive values), Conclusio: Limited dependable variable/ left limited DV.

[1]There was no need to look at the Pdf of the NAs. All NAs are in case 192 and appear only in the vignette questions. This means that one respondent answered the standard questions but stopped answering when seeing the vignette questions. This is not representative and not interpretable.

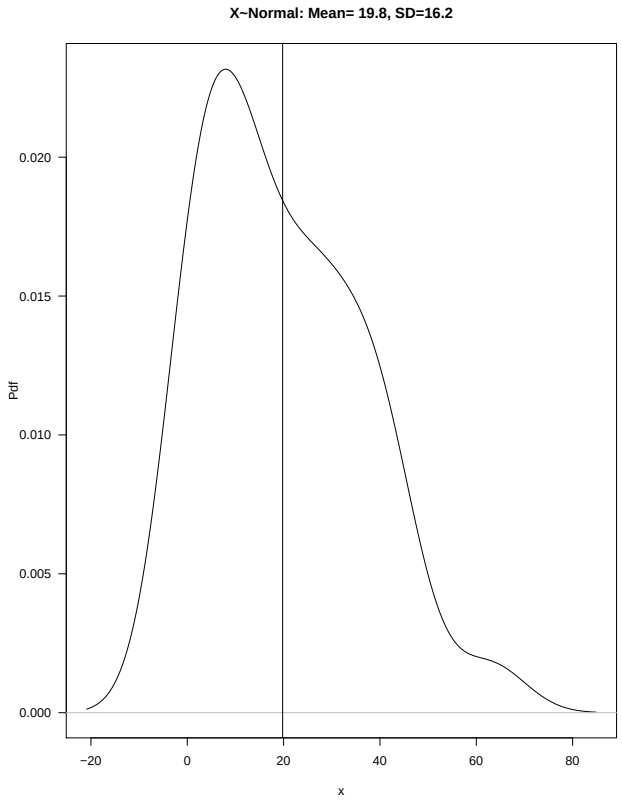


FIGURE 3.2: Distribution

The aspect, that the probability density function is heteroscedastic is out of the perspective of the statistical analysis a positive aspect. It is positive because we know now, that one of the IV introduces a strong variance in the distribution of the DV. This in turn means, if we come back to the question, whether the levels/ the IVs have a discriminating power in the perceptual space of human beings, that yes indeed, at least one of them is clearly separated in the perception of humans from the other IVs. This insight mirrors the graphic of the MDS-Analysis. The question is now what the underlying order of the levels are. This is answered in the following by separately looking at the data set from the product perspective (beef, cheese) and the dimension perspective (non-living-resource-indices and living-resource-indices).

3.5 Comparison Impact Products

The hypothesis on which the MDS above was made, that the values of the levels play a sub-ordinate role, can be rejected here in the following way: A general-linear-model with all the levels is computed (unfortunately the level canaries dropped out because the randomiser from the survey program just draw this level once). Then the coefficients are pulled separately and grouped by the products beef and cheese. Beef is assigned on the X-Axis=1, Cheese is assigned on the X-Axis=2. Orientation for the colour-code is on the right side.

The outcome is more or less intuitive, meaning that on average the higher amount of a value (Beef in drinking-water for cats: 60.000 vs. cheese in drinking-water for cats: 6.356) causes a lower value on the DV. This means in turn that the potential consumer from the target population is less certain to buy a product, if the value of

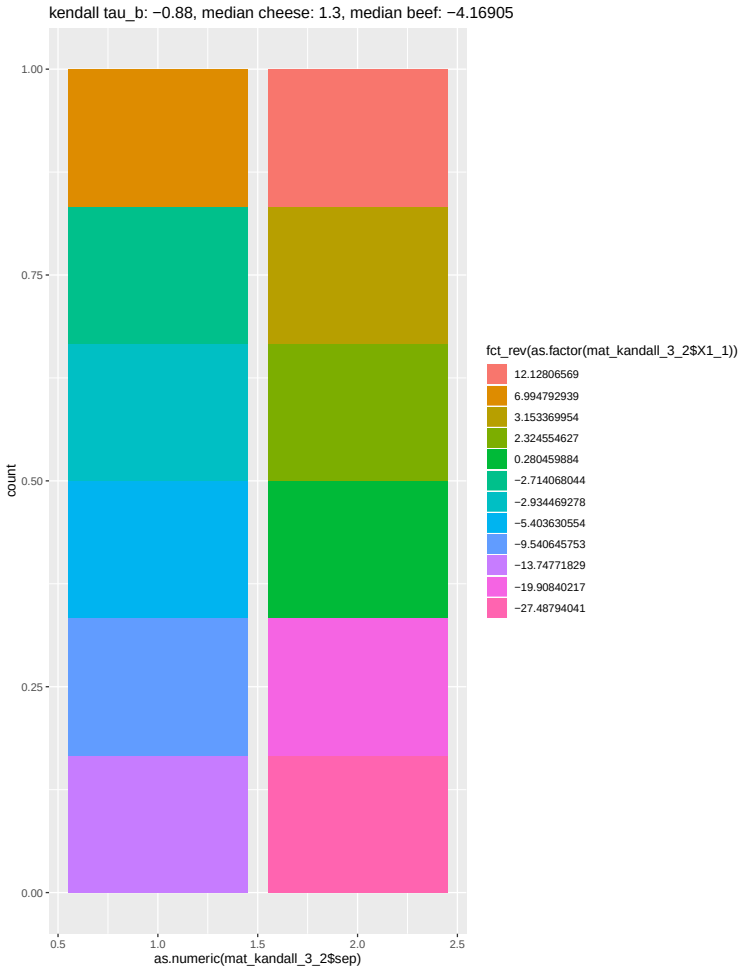


FIGURE 3.3: Comparison Impact Products

the IV is higher. The kendall correlation was chosen to express the graphic numerically (see title kendall tau_b: -0.88) because of its property to deduce ties pairwise. The correlation is strictly negative (the higher C, the lower D). So nearly every positive value of the DV caused by the product "cheese" has a negative partner caused by the product "beef".

3.6 Comparison Impact Dimensions

In the following section exactly the same process was applied as in the section above, with the only change that the distinction wasn't made between the values of the indices but between the indices groups (living-resource-indices vs. non-living-resource-indices) also referred to in this work as dimensions. The dimension living-resource-indices is assigned on the X-Axis=1, the dimension non-living-resource-indices is assigned on the X-Axis=2.

At this point it can be already stated, which will be proof further in the following, that the H_0 can be rejected. It is visualized by the plot 3.4 and numerically expressed by the mean and tauβ that the dimension living-resource-indices has a higher negative impact on the DV as the dimension non-living-resource-indices. But in order to bring the argumentation in an orderly fashion to an end, in the following the comparison between different models based on a ANOVA (see Rmd. Version,

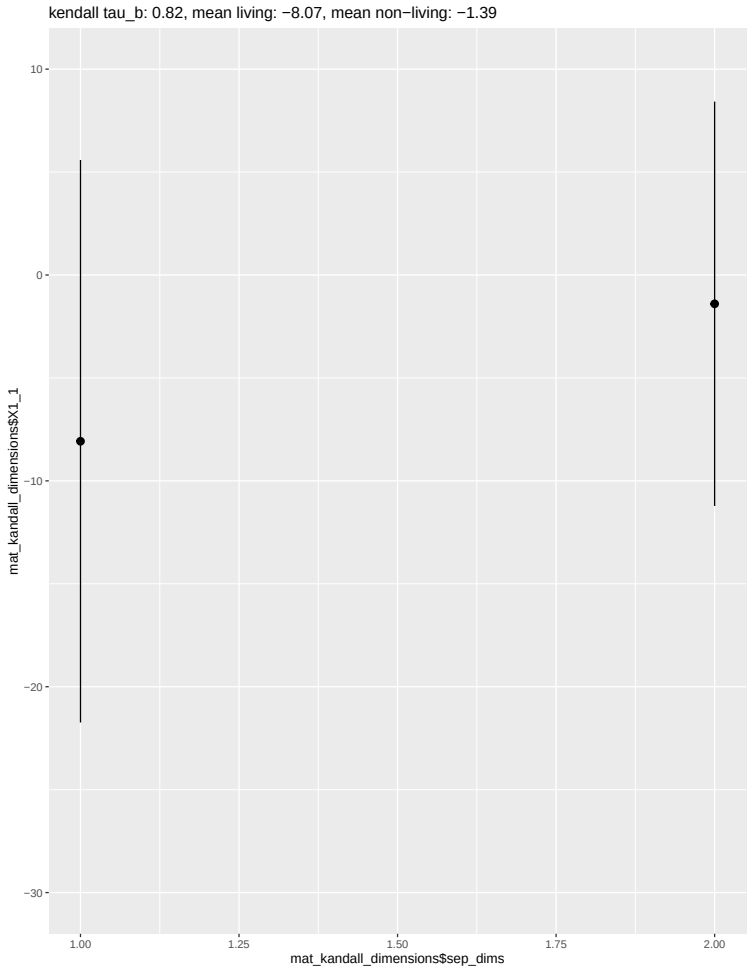


FIGURE 3.4: Comparison Impact Dimensions

also for residuals component plot (visualizes exhaustively the IV, which introduces the strongest variance.)).

3.6.1 Models

Through a conducted ANOVA, the strongest IV are found (see .Rmd Version). This is a somewhat non-theoretical approach, but definitely answers the question, which IVs introduce the heteroscedasticity mentioned above. In the model comparison (3.5) the model titled "ols" is a general linear model. Here the strength of the coefficients are overestimated. This is caused by the higher consistency of the responses from one respondent in comparison to other respondents. This in turn doesn't fulfil the assumption of independence between the observations under which the standard error is calculated. Never the less, it is shown here for getting a feeling of how strong the overestimation is.

Interpretation:

We see figure 3.5 and figure 3.6 placed side by side. They were placed that way because they have the same rows/IVs. This means that "sex.1" for "ols" and "ols cluster" is the same for "tobit", just that the variable "sex.1" is called there "x1". Starting off with the basic information, which are held by the models:

	Dependent variable:	
	OLS	OLS cluster
	(1)	(2)
sex.1	-16.279***	-16.279***
	(4.429)	(2.094)
Alter.1	-2.031***	-2.031***
	(0.583)	(0.232)
humans.beef	-15.859**	-15.859**
	(5.710)	(6.953)
humans.cheese	-26.253***	-26.253**
	(7.015)	(9.750)
cats.cheese	-9.271	-9.271
	(5.696)	(6.598)
Constant	64.132***	64.132***
	(9.031)	(4.407)
Observations	32	
R2	0.602	
Adjusted R2	0.526	
Residual Std. Error	11.168 (df = 26)	
F Statistic	7.868*** (df = 5; 26)	
Note:	*p<0.1; **p<0.05; ***p<0.01	

FIGURE 3.5: Models

	Dependent variable:
	Tobit
x1	-18.777***
	(4.805)
x2	-1.835***
	(0.625)
x3	-21.878***
	(6.747)
x4	-33.253***
	(8.541)
x5	-9.829
	(6.024)
Constant	66.117***
	(9.642)
Observations	32
Log Likelihood	-104.800
Wald Test	41.327*** (df = 5)
Note:	*p<0.1; **p<0.05; ***p<0.01

FIGURE 3.6: Tobit

1. The change from women to men causes the DV to fall by ca. 16.279. Coming now to the over-estimation of the coefficients mentioned above and the corrupted standard error. This problem is attacked here by displaying the standard error directly below the coefficients. So if we take again the IV "sex.1" we remark that the standard error gets smaller if we respect the more consistent answers of one row.

2. The younger the participants, the more they are sensitive to the stimuli. Here too the standard error is corrected down by the more robust "OLS cluster" model. This makes sense for sex and age as these two questions are standard questions and are only answered once. We will note that in the following all the other coefficients have to be corrected up, not down, because they are repeatedly shown to one participant of the survey.

3. The level "humans.beef", which is in the vignette text: "Give drinking water to 5000 humans", causes causes the DV to fall by 15.86. This level is a good example to explain the use of the standard error comparison. According to the "OLS Cluster model" the standard error must be corrected from 5.7 to 6.9. This implies that indeed the coefficient was overestimated.

4. Coming now to the level human.cheese: This is an interesting case as the number of the level in the vignette text is smaller than the number of the level human.beef (human.cheese: 530 vs. human.beef: 5000). This is one of the outliers, which wasn't pointed out jet in the section "Comparison Impact Products" (see 3.5) (Actually this was the reason for taking the median and not the mean in the comparison between the products). This is also hard to explain, as it is counter intuitive. However, it can be the case that there is some kind of threshold value in the human mind, which, if exceeded, doesn't compare any more between lower and higher numbers.

5. Getting finally to the lower section of the figure 3.5: This shows the parameters by which a model is measured. The r^2 tells us how much variance can be explained by the model. In this case it's between 50-60% which tells us that the model has quit a good fit to the variance.

   [Adjusted r^2] punishes for IVs, which don't help to explain the variance

[Residual Std. Error] Gives the average distance between the fitted line/ the linear model and the distance to the residuals

[F statistic] Gives the comparison between the intercept only model and the model with the IVs. The result: 7.86, tells us that the explained variance is greater than the unexplained variance. The interesting part is here the degrees of freedom written behind the F-Value. They tell us, that five values can freely move, that they can't be explained by the IVs but the 26 other values can be explained.

6. *Justification for Tobit Model*

The justification to introduce at this point of the work the tobit model is the following:
It was already stated (see 3.2) that the probability density function is right skewed and that the conclusion is that the DV is limited. Under the estimation that the underlying latent variable is normally distributed, this problem can be approach by estimating, in how far the DV is limited. The log likelihood estimator answers this question: The response-scale in the survey must be doubled in order to not limit the dependent variable. Originally the scale scoped from 1-101. "1" being very unsure to buy the product and "101" being still very sure. What the log-likelihood[2] tells us now is that the scale must be longer by "-104" in order to render justice to the answering behaviour of the survey-participants.

Wald Test: 41.32 indicates, that the difference between the Maximum Likelihood of a χ^2 distribution and the Maximum Likelihood Estimator of the DV if the DV wouldn't have been limited, is quit far apart $(\hat{\theta} - \theta_0)$

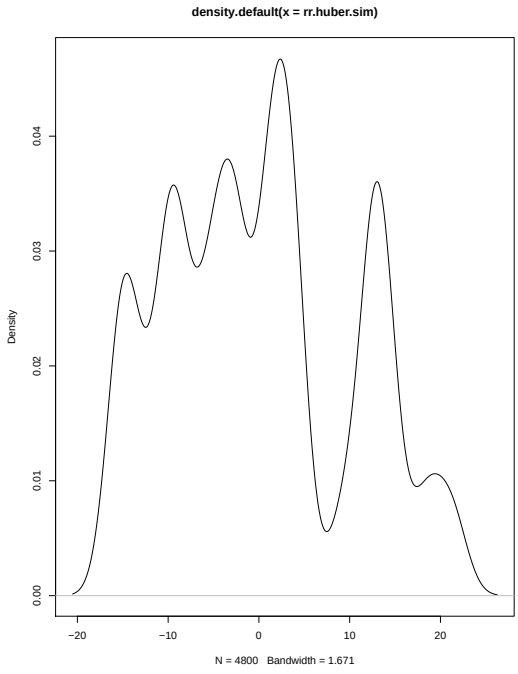


FIGURE 3.7: rr.huber

[2]One could have also considered to use "Powell's CLAD estimator" in order to account for a latent variable, which isn't normally distributed

Justification to show multiple models: Trying not to be too explicit, the key for understanding the difference between the different standard errors is: the OLS standard error assumes that the standard error has the same variance. However, what can be seen in the Figure 3.7 is a bootstrap of the residuals, which should exhaustively show that the variance is not normally distributed. The easiest way to explain the difference of the models is to say that the OLS model doesn't account for such a distribution but the clustered model does.

Chapter 4

Findings

4.1 Chapter Objective

This is the closing chapter where all the threads are tide together. The main results and limitations of the work are presented.

4.2 Main Findings

Concluding only what is already stated above in statistical terms: Only levels from the dimension "living-resource-indices" are statistically relevant. Hence the H_0 can be rejected with p<0.05 for human.beef, human.cheese and cats.cheese. This means concretely that with the possibility of less than 0.05 the tested sample doesn't lie within the 0.95 confidence interval. This hints that the H_0 is wrong. However that doesn't automatically mean, that the contrary is true, that there is a correlation between living-resource-indices and a higher uncertainty to make a purchase decision. It can also be the case that the sample doesn't represent the population. With small samples, which is considered by the standard error, this can always be the case.

4.3 Implementation Strategies

If one really wanted to take action based on these insights, one could think about an implementation like it is stated in the vignettes texts, which would be the closest scenario to the insights stated above. However, it could be helpful for achieving what is stated in the introduction (see 1.1) to broaden the view.

Indulging here in an analogy with a thought experiment based on the coase theorem (cf. Coase, 1960):
There is a village (a) where the fishers (b) live. The (b) have access to a small lake (c) with a population of fishes (d). The health of (d) is seen as indicators for the overall health of (c).

Following scenarios:

1. (b) want to maximize their outcome, which leads to the extinction of the (d) and a eutrophic (c)

2. (a) gives the responsibility for the health of (c) in a newly formed association of (b). If the health of (c) goes down, the association of (b) is punished.

A transfer to the case at hand:
There is a state (a) where the enterprises (b) operate. The (b) have access to a environment (c) with a population of consumers (d). The health of (d) is seen as indicators for the overall health of (c).

Subsuming now the indices: The indices would take the place of the "responsibility for the health of (c)", meaning that the enterprises are responsible to educate the consumers in favour of their health and the health of their environment (cf. Incorporation of pullution). Regarding the punishment of outcome 2 of the scenarios: This could consist in the reality out of payments to the healthcare-insurances or environmental-agencies.

4.4 Limitations

4.4.1 General Evaluation:

Internal Validity

A causality can be traced insofar, that the dimensions, or more explicitly, the levels, caused in their function as stimuli, reactions in the mind of the participants of the survey. Furthermore, these reactions can be discriminated as their amplitudes were differently strong (see MDS). These different amplitudes of reactions could then be analysed in the context of the research question. Insofar a clear causality is given with clear results.

External Validity

When analysing the external validity, the question is, if the results of the quasi-experiment can be extrapolated on the real world. This question was already treated by the model. Because in the model we asked, how strong the influence of the IVs is on the real world target population. And the model was rather good. However, one has to bear in mind, the point already made about the small sample size in the section 4.2. Furthermore, a very obvious weakness of the application of a vignette survey is, that reading a vignette is different from experiencing a stimulus or action in everyday life "We do not know enough about the relationship between vignettes and real life responses to be able to draw parallels between the two." (Hughes, 1998, p. 384). One could counter-argument, that the responses given in a vignette survey closely mirror the respondents "real-world-behaviour" (cf.Hainmueller, Hangartner, and Yamamoto, 2015). In order to avoid such discussions/uncertainties in the future, any further experiments in the line of the work at hand, will be conducted from the author with 3D-animations and real-world/computer-simulations instead of (merely) texts as vignettes.

Reliability

The quasi-experiment is in its entirety reproducible (0.1). This enables to find out if the results are reliable/stable. The next step to check the stability of the results would be to make the experiment with a larger sample size.

4.4.2 Concrete weaknesses:

1. One could argue, that it is obvious, that those indices, which refer to living-resources, communicate more drastically the resource efficiency of potential purchase decisions. However, there is given reason to at least consider the possibility, that the communication based on imaginary or fictional content is more effective to communicate messages (cf. Burns, 2012).

2. Regarding the choice of domestic animals

   Here a mistake has happened as one of the most preferred domestic animals (dog) was left out. This is due to a human-transfer-error. The "dog-sentences" were written in the R-Skript but overwritten when implemented in the Survey-Program. So that one could argue that for those people who are

more affectionate toward dogs than e.g. cats, this survey doesn't resonant as well. However, a counter-argument would consist of pointing out that it is better in regard to the low respondent number, to have made the mistake to leave out one level, than to have added an additional level. So that the consequence is that a higher comparability is give between the used levels.

3. Ethical considerations

   Ethical discussion are often vague. This vagueness is the reason for not diving in to one here. However, to recalculate nutrition products like "beef" and "cheese" into lives of humans, cats, bunnies etc. can be seen as deeply unethical. The reader might forgive that, if only brought to mind, what was brought up once before: "desperate times call for desperate measures" (cf. Erasmus, 1545).

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