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Communicating Sustainability in the Food Industry

The Impact of Carbon Labels on the Willingness to Pay for Food Products

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Abstract

This thesis aims to investigate the impact of carbon labels on the willingness to pay in the context of the food industry. Thereby, the study is intended to pursue the overall objective of promoting sustainable consumption. While exploring this research field, a carbon neutral label and a newly carbon footprint and traffic light code label were developed and tested. Additionally, the study examines whether trust, social identity and environmental concern contribute to explain the results.

For this purpose, an experimental online survey was conducted to compare four in a between subjects approach. Therefore, the willingness to pay, trust, social identity, environmental concern, and demographic characteristics were measured. The participants were exposed to 10 different food products to test their willingness to pay. These were manipulated with none, one, or a combination of two or all carbon labels. In total, data from 121 participants were collected, processed, and analyzed. The results showed two significant effects among the labels, namely the carbon footprint label and an interaction effect of the traffic light code and carbon footprint label on the willingness to pay for food products.

This research validates a significantly higher willingness to pay for the carbon footprint label from The Carbon Trust and an interaction effect of the traffic light code and carbon footprint label for food products.

Keywords: *Environmental sustainability, food industry, willingness to pay, carbon labels, sustainable consumption, carbon neutral, carbon dioxide, climate change*

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Sumário

Esta tese visa investigar o impacto dos rótulos de carbono na vontade de pagar no contexto da indústria alimentar. Assim, o estudo pretende prosseguir o objectivo global de promover o consumo sustentável. Ao explorar este campo de investigação, foram desenvolvidos e testados um rótulo de carbono neutro e um novo rótulo de carbono e código de semáforo. Além disso, o estudo examina se a confiança, a identidade social e a preocupação ambiental contribuem para explicar os resultados.

Para este efeito, foi realizado um inquérito experimental em linha para comparar quatro numa abordagem entre temas. Assim, foi medida a vontade de pagar, confiança, identidade social, preocupação ambiental, e características demográficas. Os participantes foram expostos a 10 produtos alimentares diferentes para testar a sua vontade de pagar. Estes foram manipulados com nenhum, um, ou uma combinação de dois ou todos os rótulos de carbono. No total, os dados de 121 participantes foram recolhidos, processados e analisados. Os resultados mostraram dois efeitos significativos entre os rótulos, nomeadamente o rótulo da pegada de carbono e um efeito de interacção do código do semáforo e do rótulo da pegada de carbono sobre a vontade de pagar pelos produtos alimentares.

Esta investigação valida uma vontade significativamente maior de pagar o rótulo da pegada de carbono do The Carbon Trust e um efeito de interacção do código de semáforo e do rótulo da pegada de carbono para produtos alimentares.

Palavras-chave: *Sustentabilidade ambiental, indústria alimentar, vontade de pagar, rótulos de carbono, consumo sustentável, carbono neutro, dióxido de carbono, alterações climáticas*

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Executive Summary

Through technological and medical advances and created access to any natural resources, humanity has been interfering with nature for a long time. Thus, changes in habitats, biodiversity and even climate could be perceived. The name of the new age “anthropocene” is intended to draw attention to the consequences of the increase in influence, humanity on the earth, and appeals to responsible, sustainable action.

After the preceding introduction, the historical course of sustainability and climate neutrality in the food industry is presented to illustrate the evolution of the topic. The ever-growing food industry has become a decisive factor for the impact of humanity on the environment, as it turns out to be the main emitter among all industries.

Chapter 2 provides an overview of the impact of food products on the environment. Due to mass production and the associated overconsumption by the society, significant social and environmental consequences can be observed. In terms of the environment, these are CO_2-emissions and the climate change and its harmful consequences. Furthermore, a theoretical background on sustainability in the food industry is reflected from the different stakeholder perspectives, on which the following chapters are based. This includes the production or company, the consumer side, and the associated consumer behavior. In particular, meat consumption and intensive livestock farming, which have had a destructive impact on the environment, have given greater importance to sustainability. In turn, sustainable consumption is defined in the context of the food industry. Furthermore, drivers for sustainable consumption are identified, which focus on social identity and environmental concern. These drivers should not be disregarded when measuring willingness to pay, as they can influence the purchase decision.

Many interventions can be observed in daily food consumption, which include sustainability labels. These range from social to environmental attributes and help consumers make information-based decisions. In the course of this, barriers that influence adoption, decision making, or purchase are first discussed. Here, the critical factor of trust in the label needs to be examined in more detail, as they can have an effective impact on the purchase decision respectively willingness to pay. Among the variety of labels, a growing number of carbon labels can be found, such as carbon footprint, climate neutral and traffic light code labels. Different

literature analyses are considered as a starting point to assess the impact of carbon labels (climate neutral, carbon footprint and traffic light code label) on the willingness to pay for food products. As these are still quite unexplored, the label from the non-governmental organization The Carbon Trust (carbon neutral) and two imitated labels (carbon footprint and traffic light code label) are tested, as this combination is recommended from previous research. However, consumers still have a low level of understanding of the topic of CO_2 and therefore of carbon labels. In this context, the question arises of how the carbon labels affect the willingness to pay.

The third section describes the methodology and data collection for the online survey, including the simulation experiment. The experimental manipulation, which had a 2 (carbon neutral label vs. no label) x 2 (carbon footprint label vs. no label) x 2 (traffic light code label vs. no label) mixed factorial design, were manipulated between subjects. The traffic light code label was manipulated within-subjects, with random assignment for all conditions. Therefore, four experimental conditions were developed. Further, the sample, process, survey design and measurements, including the variables, are described.

Fourth, the collected data are processed and analyzed. In this case, a general linear model repeated measures were conducted to be able to compare the effects and mean values of the WTP and test the hypotheses. Finally, a conclusion is drawn, which presents a discussion of the results, recommendations, and managerial implications. Likewise, limitations of the study are pointed out and further findings and future research approaches are presented.

The present work is mainly concerned with the food industry of the western cultural area. Furthermore, due to the constantly changing food industry, no completeness is guaranteed. Rather, this study aims to highlight the relevant approaches to sustainability in the food industry and in particular carbon labels.

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IV. List of Abbreviations

CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
ESFC	Environmentally Sustainable Food Consumption
EFSA	European Food Safety Authority
EU	European Union
FAO	Food and Agriculture Organization
GHG	Greenhouse gas
GHGe	Greenhouse gas emissions
GHGs	Greenhouse gases
GLM	General linear model
SDG	Sustainable Development Goals
UN	United Nations
WTP	Willingness to pay
WWF	World Wide Fund for Nature

1. Introduction

1.1 Background

Climate change is omnipresent and affects an ever-increasing number of people around the world. It is progressing at an alarming rate and is becoming increasingly evident. Since the industrialization, the global temperature has been progressively rising, which, according to scientific research, is caused by humans to a great extent. Hence we speak of anthropogenic, the human-induced climate change (Umwelt Bundesamt, 2010). In the same course one increasingly finds interventions[1] to mitigate climate change as carbon labelling (e.g., climate neutrality or carbon footprint[2]) on food and other products. However, from the consumers point of view, it is not entirely clear what these actions signify (tcl, n.d.).

Looking at the European emitted tons of carbon dioxide (CO_2) equivalent[3] (CO_2e) per capita in 2019, Germany (9.7) is in the upper midfield, Portugal in the first third (about 6.1) and Malta with the fewest emissions (4.3) (Wilke, 2013). However, if the benchmark of under one ton per capita per year of CO_2e is taken into account (Umwelt Bundesamt, n.d.) to limit the temperature increase to 1.5°C (United Nations, 2015), all European countries surpass the maximum value. Scientists agree, that the failure to limit the temperature rise will have devastating consequences, such as ice melt and sea level rise, extreme weather events, social and economic costs and threats to wildlife and plants, are not only severe but will intensify if no action is taken (Masson-Delmotte et al., 2021).

Moreover, greenhouse gas[4] (GHG) emissions and temperature rise have a nearly linear relationship, implying "that if temperature rise is to be brought to a halt, so must emissions" (Lahn, 2020, p. 15). To mitigate climate change, an international legally binding agreement, the *Paris Agreement*, was adopted on December 12, 2015 (*The Paris Agreement | UNFCCC*, 2015.). According to article 2 (a), the central goal, the global average temperature needs to be limited "well below 2°C above pre-industrial levels and pursuing efforts to limit the

[1] "The action of becoming intentionally involved in a difficult situation, in order to improve it or prevent it from getting worse" (Cambridge Dictionary, n.d.).

[2] "A product´s carbon footprint is the total amount of GHGs it emits throughout its life cycle, expressed in kilograms of CO_2 equivalents" (FAO, 2013, p. 16).

[3] "A CO_2 equivalent is a unit of measurement that is used to standardize the climate effects of various greenhouse gases" (myclimate, n.d.).

[4] As GHGs count: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and, sulfur hexafluoride (United Nations, 1998).

temperature increase to 1.5°C above pre-industrial levels“ (United Nations, 2015, p. 3). Furthermore, article 4 refers to carbon neutrality, which is to be achieved by the middle of the 21st century (United Nations, 2015). This not only indicates that climate neutrality is a process and is not meant to be achieved immediately, but is a strategy to stay “below the 2°C threshold, for its part, of 1,150 Gt”, which “would be exhausted in about 25 years”(MCC, n.d.). Therefore, the European Union (EU) aims to become climate-neutral by 2050 (EU-Klimaneutralität bis 2050, 2021). The issue of the term “climate / carbon-neutral” is that it is not protected by law, leading to missing legal frameworks for companies and products (Bayerisches Landesamt für Umwelt, n.d.), causing a lack of transparency for consumers as no standardized approach exists. Hence, the question arises what climate neutrality implies.

To achieve climate neutrality, a closer look at the underlying causes is needed, in this case the emitters. Here, the attention drifts quickly towards major industries and their share of GHG emissions (GHGe), whereas more than one third accounts for the food industry (United Nations, 2021), with CO_2 emissions presenting the largest contribution (US EPA, 2017). What makes the fact even more devastating is that one third of produced food is not even consumed and ends up as food waste (FAO, n.d.). Meaning, 8-10% of global GHGe is accounted as food waste (UNEP, 2021). Furthermore, the consumption of various food products, meat in particular (emitting the most greenhouse gases (GHGs)), is excessive on a global scale (Willett et al., 2019). On the one hand, the food industry can be considered as a major driver of GHGe in combination with overconsumption and food waste; on the other hand, carbon footprint is of special interest as climate change affects society and entails consumer behavior to be an important role for action. As the reduction in GHGe starts with an individual acting environmentally friendly to shift the general consumption towards sustainability.

It can be argued that food production and consumption affect not only our planet, but also human health, expanding the negative effects from the environment to the people. Considering this, the *Eat Lancet Commission* released the influential *Planetary Health Diet report* in 2019 to assist achieve both the *Sustainable development Goals* (SDGs) and the targets set out in the *Paris Agreement*. In this report evidence-based global goals for healthy diets and sustainable food production are described (Willett et al., 2019). This indicates that a win-win situation for planet and people could arise if actions are taken in respect of climate protection (Oatly, 2019).

Market-regulating measures have already been implemented, such as a carbon taxes and trading, to influence demand by price increment (Camilleri et al., 2019). Given this, it is evident that a structural change in society and the food industry is required, addressing not only companies, but the individual consumer. A less regulatory but more empowering approach is to adapt consumers to climate change. Therefore, information provision, is crucial "to empower consumers to make informed choices" (Thøgersen, 2005). Likewise, Tobi et al. (2019) found that information provided on food labels can drive the consumer towards sustainable consumption. This deficiency is not only due to confusion, the lack of knowledge about CO_2 emissions and the "underestimation of environmental impacts of different types of food" of consumers (Camilleri et al., 2019, p. 1), but contradicts with the fact that CO_2 emissions account for the largest share of GHGs. The scheme behind labelling is either voluntary (non-certified) or regulated (certified) controlled by government or/and private organizations (Janssen & Hamm, 2012), whereas eco-labels (120 out of 463 schemes are active in the EU) are mostly controlled voluntarily or privately (Tobi et al., 2019). Due to the vast number of labels, barriers have emerged that reduce the adoption of these labels, with a lack of trust being a significant component. Therefore, Hanss and Böhm (2012) observed that consumers need to be familiar with sustainability labels to buy a product. Considering this, trust is a crucial factor.

One can observe an increasing number of companies that focus on the climate neutrality of products including food. In Germany there are certified climate neutral labels from *ClimatePartner*, *Carbon Trust*, *myclimate* and *klimaneutral*, which provide CO_2 offsetting[5] for food products. So far, the number of certified climate neutrality labels is limited in contrast to other environmental labels (Siegelklarheit, n.d.). Likewise, the research on the impact on the consumers' buying behavior of said labels is rather thin.

Consumers' increased awareness of sustainability and social responsibility results in their WTP for more healthy, ecologically and fairly produced food (Ernst & Young, 2007). Simultaneously, an increase in demand for labels that estimate CO_2 emissions as the carbon footprint was found, with studies being indifferent about their impact on the consumer's food choice (Caputo et al., 2013; (Thøgersen & Nielsen, 2016; Camilleri et al., 2019; Brown et al.,

[5] Mitigation Approaches: "**Avoid:** measures taken to avoid creating impacts from the outset or set aside key conservation areas; **Reduce:** measures taken to reduce the intensity and/or extent of impacts that cannot be completely avoided; **Restore:** measures taken to restore degraded ecosystems or capture some energy/material benefit; **Compensate:** measures taken to compensate for any significant residual, adverse impacts that cannot be avoided, reduced and/or restored" (Stevensen, 2020).

2020). On the one hand Brown et al. (2020) found that labels' impact on food purchase behavior is uncertain, whilst on the other hand Camilleri et al. (2019) show that information about GHGe on food products can influence consumers towards the lower-emission option. Therefore, the provision of GHGe-information can be seen as a "blind spot" for interventions to "boost" consumer decision making (Thøgersen & Nielsen, (2016); Camilleri et al. (2019). To maintain a common understanding, the numerical CO_2 emissions[6] value is defined as "carbon footprint". An example is the company Oatly which numerically declares the carbon footprint of its own products since 2018 (Faust, 2020), putting CO_2 emissions signaling into practice. By appealing to other companies and the government, they argue that mandatory CO_2 emissions labelling of products would allow consumers the opportunity to compare the climate impact of their purchases at the point-of-sale. Further, Oatly argues that the currently voluntary carbon footprint disclosure could create more transparency and potentially influence the consumer decision-making process if it becomes obligatory on food products. Likewise, the German law gives consumers the "right of information" about the products they consume. An informed, environmentally friendly purchase decision can only be made if consumers are empowered to evaluate and compare the climate impact of their food products. Consequently, a petition for the declaration of the carbon footprint on food products argues that the declaration falls under consumer rights and is, therefore, the responsibility of the government (Deutscher Bundestag Petitionsausschuss, 2019). An additional problem is the lack of a reliable (Faust, 2020) and standardized carbon footprint accounting. Since there is no legal regulation in Germany yet, different approaches are performed which ultimately affect the measured performance. Thus, the performance measurement is highly information dependent (Gibassier & Schaltegger, 2015). The lack of standardized regulations for the measurement of carbon footprint and the rather scarce study base on CO_2-related labels can be attributed to the relative novelty of CO_2-related labels, which contributes to the fact that one's environmental impact of consumption is difficult to understand and track. Additionally, as the number of carbon labels increases, it is particularly important for marketeers to be aware of them and to be able to deploy them in a targeted manner. Additionally, Emberger-Klein and Menrad (2018) found that consumers prefer scale labels that use a traffic light code, which tends to shift choices towards low-carbon products. This might counteract the underestimation of the environmental impact of the products and promote sustainable consumption.

[6] The common practice is to name the carbon footprint as CO_2 equivalents, or CO_2e. The total impact of all GHG is translated into the amount of CO_2 which would have the same impact (Berners-Lee & Clark, 2010).

Since consumer responses are complex and sometimes unexpected the overall impact of carbon labels is still uncertain (Onozaka et al., 2015). There have been studies on preference for carbon label design (e.g., Berry et al., 2008; Vanclay et al., 2011) and on the WTP (e.g., Caputo et al., 2013; Van Loo et al., 2014) already, which is why this thesis aims to go further to analyze the impact of different carbon labels on the behavior intent, WTP, for sustainable food products particularly with a decision aid, the traffic light code label.

1.2 Research Objectives & Questions

This thesis aims to assess the impact of different carbon labels on the WTP, while controlling for drivers (environmental concern and social identity) for sustainable consumption. These drivers are control variables. According to the given background information, carbon labels contribute to a change towards sustainable food production and consumption, which is why the following research question will be examined:

RQ1: What is the impact of carbon labels on the consumers' WTP in the context of food products?

Based on this, the carbon labels are adjusted with a traffic light code label to test the WTP, resulting in the second research question to be:

RQ2: What is the impact of climate neutrality labels and the carbon footprint label combined with a traffic light color label on the consumers' WTP in the context of food products?

1.3 Scope of the Study

Ten food products from different categories, easily available across Europe, were pre-selected. Additionally, the thesis focuses on the GHG CO_2 and not on other GHGs, as it represents the highest emitted emission and is a known communicated GHG, as the other five GHG are mostly calculated in CO_2e. Furthermore, the thesis limits itself to the communication tools labels, as they are a widely used and straightforward instrument to communicate information that consumers have already adapted as decision aid. For this purpose, persuasive aid symbols (carbon labels) are used to test whether sustainable consumption can be stimulated. As

described, many studies have already found that labels can increase WTP. Another factor to consider is that labels enable consumers to make more informed purchasing decisions, which in turn leads to consumers being more educated about the product's attributes. This educational approach can create added value, making the consumer willing to increase their WTP if applicable. Since labels convey different attributes, it is suspected that their impact on WTP differs, which leads to the subsequent hypotheses.

1.4 Research Approach and Methods

This work follows a deductive approach, starting with a literature review (qualitative) followed by an online experiment. The survey assessed 121 potential consumers who took part in an online questionnaire, with an online experiment, allowing primary data to be collected. The experiment tested the below-stated hypotheses on 10 different food products, whereas the product presentation was manipulated with the main independent variables: carbon footprint label, carbon-neutral label, and a traffic light code label, to measure the dependent variable WTP. Furthermore, control variables are assessed. The following hypotheses were examined:

H1: Having a carbon neutral label (vs. no carbon-neutral label) increases the WTP for food products.

H2: Having a carbon footprint label (vs. no carbon footprint label) increases the WTP for food products.

H3: Having a traffic light code label (vs. no traffic light code label) increases the WTP for food products.

H4: Having a carbon neutral label and carbon footprint label (vs. no label) increases the WTP for food products.

H5: Having a carbon neutral label and traffic light code label (vs. no label) increases the WTP for food products.

H6: Having a carbon footprint label and traffic light code label (vs. no label) increases the WTP for food products.

H7: Having a carbon neutral label, carbon footprint label and traffic light code label (vs. no label) increases the WTP for food products.

1.5 Relevance

It is important to understand consumer behavior and perceptions about GHG and CO_2 emissions to ensure that interventions such as labels can be used effectively. Consumers are thus informed in a targeted and effective approach and gain a clearer understanding of their purchasing behavior. By simultaneously increasing transparency, creating awareness and a shift in consumers' needs, pressure is exerted not only on consumers, but also on companies and producers, which can lead to lower emission products. Especially responsible communication and marketing as a mediator have great potential to encourage sustainable consumption by not only informing but educating consumers. Furthermore, companies are part of the value creation of individuals, which is why a socially sustainable approach becomes even more important (Buerke et al., 2017).

1.6 Dissertation Outline

Chapter 1 introduces the problem, gives profound background information, presents the research questions, approach, and relevance. In chapter 2, a detailed literature review about the state-of-the-art is conducted, on which the hypotheses are reviewed and obtained. These will be tested with data derived from an online experiment. Chapter 3, the research methodology, describes the methodology and the design of the questionnaire that has been applied to collect primary data. According to this, the collected data will be displayed and analyzed to implicate practical suggestions on how to improve the impact of carbon labels in chapter 4. Lastly, chapter 5 addresses the discussion of the findings, the study's limitations of the research and the validity are highlighted. Finally, future research is pointed out, with respect to motivating researchers to follow up on this topic.

2. Literature Review

To provide a common understanding, the terminology and theoretical background of sustainability in the food industry will be discussed initially. Secondly, environmentally sustainable food consumption, including the production and sustainable consumer buying behavior, is examined. Thereby, all independent variables, namely carbon footprint, carbon-neutral and traffic light code labels as well as the main dependent variable WTP, are examined. Lastly, control variables (environmental concern and social identity) are introduced, which effects must not be disregarded. These will be referred to by existing research, and finally lead to the derivation of the main hypotheses.

2.1 Sustainability in the Food Industry

According to the World Commission on Environment and Development (1987), three dimensions of sustainability can be identified, which form the foundation of various sustainability models and should be addressed simultaneously on a global scope. The ecological dimension deals with the negative impacts of human actions on the ecosystem through their satisfaction of needs and interventions. This includes, for instance, resource extractions that burden nature and affect biodiversity. To mitigate the impact on the ecosystem, natural regeneration should not be exceeded and human health should be protected (Caspers-Merk et al., 1998). The second economic dimension refers to the business activities that are intended to ensure long-term success (Colsman, 2016). In this context, efficient use of scarce resources is demanded, whereby unnecessary waste of resources is to be prevented (Caspers-Merk et al., 1998). Thirdly, the social dimension (Colsman, 2016) emphasizes primarily the fair distribution of goods and equal opportunities from a global perspective, which is the requirement for peace and sustainable development. This includes the intergenerational satisfaction of fundamental needs: health, housing, clothing, and human and personal rights. Also, social resources that promote the common welfare are included, to create peace and form the foundation of a solidary society, by solidary behavior, integrity and tolerance (Grundwald & Kopfmüller, 2012). Looking at the consumer purchasing decision, predominantly the environmental and social dimensions can be observed (Colsman, 2016). This rather imbalanced perception of sustainability may be due to the labelling of attributes (e.g., through labels) to facilitate an understanding of a complex problem such as climate change (Food ingredients Global, 2018).

Given these facts, the underlying paper will concentrate on the ecological and label-based approach to achieve the greatest possible impact on consumers.

Global interventions are needed to create a change in the food industry and at the same time in consumer behavior (Willett et al., 2019). Therefore, the UN adopted 17 SDGs (Appendix 1) in the 2030 Agenda for sustainable development in 2015. It can be observed that the food industry is increasingly becoming the subject of discussion. For instance, the indicators for six SDGs (2, 5, 6, 12, 14 and 15) are monitored by the Food and Agriculture Organization (FAO) of the UN and are crucial for the food and beverage industry (Food and Agriculture Organization of the United Nations, 2020). Followed by the SDGs the *European Green Deal* was published in December 2019, which aims to align human well-being and climate neutrality, indicating that the problem of CO_2 emissions is gaining significance. Regarding the roadmap, one of the key actions is to reduce the EU's net GHGe to zero by 2050, making the EU the first continent to achieve climate neutrality (European Commission, 2021). “More ambition" is the title of the 2030 climate and energy policy outline, raising the previous target of a 40 percent reduction in EU GHGe (compared to 1990 levels) by 2030 to a 50 to 55 percent reduction (European Commission, n.d.). In this respect, the focus is not only on the GHG CO_2, accompanied by specific targets but on the *Farm to Fork Strategy* - the heart of the Green Deal. It focuses on the challenges of sustainable food systems and acknowledges the inseperable connections between healthy people, societies, and the planet. One of the 27 measures, is to reward CO_2 offsetting (European Union, 2020). With this incentive, an increase in CO_2-emissions offsetting measures can be expected, giving carbon labels greater relevance.

Considering the number of reports and measures within a short period of time, it can be concluded that a food industry transformation is only possible by changing the way food is produced and consumed. This indicates that diets must be healthier and food losses and waste significantly reduced while improving food production in terms of sustainability and therefore CO_2 emissions. Accordingly, carbon labels on food products illustrate exactly the interface of promoting sustainability and healthy consumption.

2.1.1 Food Groups and Their Environmental Impact

An overview of the value chain of food production (Appendix 2) shows farming as the largest source of GHGe, with meat production standing out the most. Looking at the environmental impact narrowed down to food servings (Appendix 3) reveals that meat again, including fish, represents the highest environmental impact. Within the EU it can be observed that 10.3% of the GHGe comes from agriculture, whereby 70% is caused by animal-based products (European Union, 2020). In contrast, all plant-based products show a relatively low GHG value, besides vegetables and fruits having higher values in e.g., energy use (Appendix 3). The increased energy consumption can be attributed to refrigeration in transport and storage. For instance, products such as meat or milk powder (dairy) have one of the highest energy demands, partly due to „higher hygienic standards and cleaning requirements“ (Ladha-Sabur et al., 2019, p. 2).

Thus, a plant-based diet is more climate friendly, while consuming meat can be considered as the bottleneck of any diet trying to be sustainable. Meaning that the consumption of meat alone can put the environmental impact of one's diet on a high level.

2.1.2 Sustainable Food Production

The supply side is the one on which companies operate to produce, offer, and communicate sustainable products (Buerke et al., 2017).

> "A universal definition of sustainable food production should use a system-wide assessment of environmental effects of a comprehensive set of parameters at various scales. GHGe, land and water use, nitrogen and phosphorus application, biodiversity loss, and chemical pollution from herbicides and pesticides are increasingly assessed and used in definitions of sustainable food production." (Willett et al., 2019, p. 461).

This section does not go further into the different parameters and the production process, to remain within the scope. Rather, the corporate side is analyzed, as they are responsible for the communication of CO_2-related information. Through information and marketing activities, companies have the influence to raise awareness (as with labels) about problems in the supply chain (OECD & FAO, 2019), and thus impact consumer behavior by making them visible and transparent. The fact that the production of food is a main driver of climate change, underlines the need for "a transition of sustainable food production" to shift towards global sustainable development (Willett et al., 2019, p. 461).

2.1.3 Environmentally Sustainable Food Consumption

Sustainable production is only one side of the coin, presenting the supply side. The other side is the environmentally sustainable food consumption (ESFC), the consumer side. As concluded, one's diet behavior, which implicates the consumption of certain food products, has significant influence on one's climate impact. Therefore, ESFC gains momentum, which is the intake of food products "that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations" (Oslo Roundtable on Sustainable Production and Consumption, 1994). Therefore, ESFC can be considered as an umbrella term that puts several key problems together.

A global comparison of the consumed quantity of food per category shows that animal-based and starchy products, in particular red meat, are overconsumed. Whereas, vegetables and fruits, which constitute the major portion of an environmental-friendly and healthy diet, are underserved (Willett et al., 2019) (Appendix 4). Together with previous findings, overconsumption of products with the highest climate impact can be observed, which multiplies the effect on the climate. This makes a transformation of the food industry and consumer diet behavior not only necessary but urgent.

2.1.4 Sustainable Consumer Buying Behavior

As the food industry is one of the major GHGe drivers consumers have a significant role in mitigating climate change and fostering a sustainable society (Vanclay et al., 2011). A way of enabling people to adopt sustainable buying behavior is the provision of eco-labels (Onozaka et al., 2015). According to the Value Belief Norm Theory, the interest in environmentally conscious consumption can be divided into three value orientations (egoistic, altruistic and biospheric) (Hoffmann & Akbar, 2016), which frame the motivation to buy environmental-friendly (Young et al., 2009). The motivation to buy sustainably can be rooted in manifold factors. These include social norms, intention, attitude, and beliefs, which cannot be disregarded, as they influence consumer behavior besides product exposure (Jackson, 2004). Additionally, a study on consumer behavior toward sustainable products found that a deficiency of presented product information resulted in respondents discarding sustainability attributes (Young et al., 2009).

2.1.5 Drivers (Antecedent Variables) for Sustainable Consumption

According to statistics, German consumers are willing to cut out products that do not meet sustainability standards; in fact, over one out of four has already stopped purchasing certain products (Statista, 2021b).

2.1.5.1 Environmental Concern

An altruistic motive is the moral obligation towards future generations that motivates consumers to act climate-friendly (Lorenzoni & Pidgeon, 2006). According to a study by Thøgersen and Nielsen (2016), a carbon footprint label is more effective if the consumer has climate protection as a goal. In a choice experiment, researchers found that the more environmentally concerned they were, the more important the carbon footprint label was (Thøgersen & Nielsen, 2016). In line with this, Feucht and Zander (2017) found that consumers are both interested and concerned about climate change and are willing to contribute to climate change action.

2.1.5.2 Social Identity

With social-identity individuals distinguish themselves and, conversely, it serves to conform to the values, beliefs, and behaviors of a social group to which one belongs (Christensen et al., 2004). Likewise, identity has an influence on purchase choice and intention in relation to CO_2 (Camilleri et al., 2019; Whitmarsh and O'Neill (2010)). Thus, environmental and climate protection in combination with the purchase of organic food is priority (BMEL, 2020). Whitmarsh & O'Neill (2010) found that one's social identity, as a "carbon offsetter" is a behavioral determinant when it comes to offsetting emissions. Adding to this, they also asked generically about the 'pro-environmental' social identity that also influenced offset intention, in spite of the fact that the influence was not as significant as for the more specific identity dimensions.

2.2 Carbon Labels on Food Products

This section identifies tools to shift consumer behavior towards sustainability and refers to the SHIFT framework and influences the WTP for sustainable food products, which serve as a basis for the empirical part.

Carbon labels can be considered as tools, signaling pro-environmental attributes of products. Looking at the SHIFT (social influence, habit formation, individual self, feelings and cognition, and tangibility) framework, which identifies a variety of psychological factors that influence sustainable consumer buying behavior (White et al., 2019), carbon labels can be categorized to feelings and cognition (F). Also, White et al. (2019) suggest providing consumers with relevant information to consumers via eco-labels, which is why this approach is utilized in this thesis. Therefore, climate labels are an essential marketing tool for climate-friendly products and help consumers to distinguish a climate-friendly product or service from a standard product (Guenther et al., 2012; Fui Yeng & Yazdanifard, 2015). Especially carbon labels help consumers' to understand the carbon footprint of a product, by indicating "the amount of CO_2 and other GHGs emitted during the production, distribution, use and disposal of a product." (Guenther et al., 2012, p. 446). They can vary depending on the producer's commitment to offset GHGe (climate-neutral label), providing a numerical estimation of CO_2-emissions to a traffic light-scheme indicating the level of GHGe (Schaefer & Blanke, 2014). Research has found positive preference towards carbon labels (Van Loo et al., 2014; Thøgersen and Nielsen, 2016). This section identifies drivers (carbon labels) that refer to the SHIFT framework and influence the WTP for sustainable food products, which serve as a basis for the empirical part.

This study focuses on the following labels (independent variables), which communicate the environmental impact of food products:

- Climate-neutral label (signifies GHGe offsetting)
- Carbon footprint label (the absolute CO_2e-value)
- Traffic light code label (a color code to show the CO_2e- level) solely and in combination with the carbon footprint and carbon trust label.

2.2.1 Barriers for the Adoption of Carbon Labels

Labels are an essential part of the food system infrastructure today, which also pose barriers to their adoption, leading to missing success of the establishment of carbon labels. Therefore, Hanss and Böhm (2012) state that consumers need to be familiar with sustainability labels to order to make an informed purchase.

Trust and transparency for labeling schemes are essential if they are to be useful and encourage change in individuals or industries (Brown et al., 2020). Whereas, a lack of trust in information sources and skepticism about the impacts of climate change are obstacles (Lorenzoni et al., 2007). Regarding sustainability labels, sustainability is a "credence attribute, which means that consumers cannot evaluate it personally". This implies a high involvement of uncertainty as consumers must believe and trust what is communicated. Furthermore, research suggests that a lack of trust regarding certified organic labels is a barrier to buy organic food (Yiridoe et al., 2005). Likewise, Janssen and Hamm (2012) found that uncertified organic labels are less trusted, but they also found that the highest price-premiums were paid for well-known and trusted labels. Thus, it can be concluded that certified labels are more trustworthy. Consequently, Janssen and Hamm (2012) advise using well-known organic certification labels that consumers trust. Due to the great number of existing certified and non-certified and especially eco-labels, Leire and Thidell (2005) found that confusion among the consumers is widely spread, which leads to decreasing credibility and thus trust. A part of the problem can be the implication of the carbon footprint and the scientific controversy, as the carbon footprint computation is not standardized yet (Burger et al. 2010; Onozaka et al., 2015).

Recent research found that consumers have a lack of knowledge regarding the comprehension of the CO_2-emission value of food products, resulting in less information-based purchasing decisions. (Tobi et al., 2019; Camilleri et al., 2019). Since climate change is considered abstract and complex, consumers have difficulty understanding it and linking it to their daily activities (Lorenzoni & Pidgeon, 2006).

Moreover, it is important that the presented information is easy to understand (Leira & Thidell 2005; Röös & Tjärnemo, 2011; Feucht & Zander, 2017; Camilleri et al., 2019), whereas Leira and Thidell (2005) found that a single symbol is not sufficient. An additional important factor is making labels visible, which can be achieved, for instance, with a good design (Annunziata et al., 2019).

2.2.2 The Climate Neutral Label

There are several certified carbon neutral labels indicating carbon-neutral production by carbon offsetting (Siegelklarheit, n.d.). According to the German government-led platform *Siegelklarheit*, four certified carbon neutral labels in the German food market can be identified: *The Carbon Trust Footprint Label, ClimatePartner, Klimaneutral* and *myclimate*. Until now, climate-neutral labels allow no more detailed comparison between products apart from the absence or presence of these labels. Examining the labels reveal that they also do not contain information about the absolute CO_2e offset value and how they were offset. According to the Carbon Trust Company, it was found that 42% of consumers believe it is important to know that a company is taking steps to reduce the product's GHGe before purchasing a product. To this end, 64% of participants would respond positively to a company that has reduced its GHGe (The Carbon Trust, 2020). Likewise, the company *ClimatePartner* has found that 74% of consumers would use a climate-neutral label as a decision-making aid while shopping (ClimatePartner, 2021). However, an advantage of these labels is that they are clearly identifiable and understandable, since their messages are clear and require little foreknowledge (Berry et al., 2008). Likewise, understandable communication and information provision can positively influence consumers' choice towards climate-neutral products (Lombardi et al., 2017).

2.2.3 The Carbon Footprint Label

The system behind carbon footprint labels is based on the assessment of CO_2e-value, which can be broadly defined as the environmental impact of a product. A CO_2e-value label (carbon footprint) can be found in markets such as Canada, France, Japan, South Korea, Thailand, or the UK. The supermarket chain Tesco (UK), for instance, used a carbon footprint label from the non-governmental organization Carbon Trust, which was according to a Tesco customer survey difficult to understand (Guenther et al., 2012).

Furthermore, research shows that the cause of climate change, GHGe, is easily understood by the public. However, there is uncertainty in understanding the GHGe value during food production (Jungbluth et al., 2000; Guenther et al., 2012; Caputo et al., 2013), which indicated that GHGe, including CO_2-emissions, need to be communicated with aid to enable consumers making conscious purchasing decisions. Therefore, studies found that additional information about GHGs impacts the purchase choice towards the low-emission option. This requires

interventions that provide relevant knowledge and decision support to "boost" consumer decision making (Thøgersen & Nielsen, (2016); Camilleri et al. (2019)). Hence, Camilleri et al. (2019) found that providing information about the CO_2e value of food in an understandable way increased the tendency of consumers to choose low-emission options compared to when no information about GHGe is provided. In their first study participants estimated the energy units in producing and transporting foods with a reference value (energy consumption of a light bulb). The second part of the first study was identical, except that the reference value was complemented with the information that the light bulb releases 100 units of GHGe. The result shows that consumers significantly underestimated the energy consumption and GHGe associated with food. This shows consumers being insensitive to differences in GHGe for most foods but relatively sensitive to differences in GHGe between meat and meatless products, with red meat being the most underestimated. This significant underestimation of environmental impact may have implications for consumers' food choices, as they may be unwilling to avoid high-GHGe foods such as meat as they are unaware of the environmental impact. In the second study, participants were presented with a menu of three beef soups and three vegetable soups and were told to buy three cans with the money they received. The control group had information about the name, a picture, serving size, price, calories, and macronutrient information. The label-group received information about CO_2e, "light bulb minutes," and a color scale ranging from "lower carbon footprint" (green) to "higher carbon footprint" (red). The results suggest that participants with CO_2 labels purchased fewer cans of beef soup than participants in the control group.

2.2.4 The Traffic Light Code Label

Previous evidence states that consumers need aid to understand the CO_2e-value of food products, which indicates that additional information about the CO_2e is needed to achieve positive impacts, in terms of a higher WTP (Caputo et al., 2013). Another method to improve the understanding of CO_2-emission impact, next to CO_2-emissions labels, is the use of a traffic light code system with the colors green, yellow and red, and “stop” and “go” logic to classify foods according to their CO_2e-value. In a focus group study by Berry et al. (2008), perceptions of five types of labeling were examined and found that such traffic light code was most appreciated because it was familiar and easy to interpret. Enhancing the product labelling with a traffic light code could fulfill multiple purposes of informing consumers and simplifying their decisions (Röös & Tjärnemo, 2011; Trudel et al., 2015). For instance, Thøgersen and Nielsen

(2016) confirmed in their experiment that the carbon footprint label in combination with traffic light code amplifies consumers' choice towards CO_2-emissions poorer products and away from CO_2-emissions stronger products. Likewise, Trudel et al. (2015) found that non-dieters consumed more when products were labelled with a green code.

The three labels were chosen firstly due to their novelty (carbon neutral and carbon footprint label) and secondly to the fact that research in this area is very scarce. Furthermore, the choice and combination of these labels are based on recommendations from previous studies (especially the traffic light code label) to test whether the knowledge gaps of previous researchers can be filled. Besides, the three labels communicate different and possibly complementary attributes ranging from a numerical (carbon footprint label), offsetting measure (carbon neutral label) to comparative information (traffic light code label), presenting a range of different carbon labels.

2.3 Willingness to Pay

WTP refers to the maximum amount of money a person would pay for a product or new product attribute that is not on the market and therefore has no market price (Haab & McConnell, 2002). Different methods have been used by economists and market researchers to determine consumers' WTP for specific product attributes, as the contingent valuation method, a widely used procedure that asks respondents to indicate their WTP for a product attribute on a hypothetical market (Haab & McConnell, 2002).

In terms of sustainability labels there are already many studies that have compared consumers' WTP for various sustainability labels (e.g.: Rodríguez et al., 2008; Röös and Tjärnemo 2011; Janssen and Hamm, 2012; Van Loo et al., 2014; Echeverría et al., 2014). The results of these studies indicate that e.g. a high price represents the greatest barrier to buying sustainable products, as environmental friendly products are perceived as more expensive and resulting in a higher WTP (Röös & Tjärnemo, 2011, p. 988). Similarly, Rodríguez et al., (2008) and Röös and Tjärnemo (2011) found a positive impact of sustainable products, as consumers paid a price premium. This is confirmed by Echeverría et al. (2014), who observed that consumers paid 29 percent more for milk and 10 percent more for bread above the average price. Janssen and Hamm (2012) even showed that organic certificated labels lead to significantly higher WTP.

On the other side, there are studies, as from Van Loo et al. (2014) which had different findings, by comparing consumer preferences for sustainability claims including the carbon footprint. Thereby, they found that carbon footprint labeling is less attractive for consumers as the WTP was relatively low. Since more studies have measured a positive impact, i.e., that consumers would pay more, the present study hypothesizes a higher WTP for carbon labels.

2.4 Research Model

Considering the hypotheses, the following research model was proposed and tested:

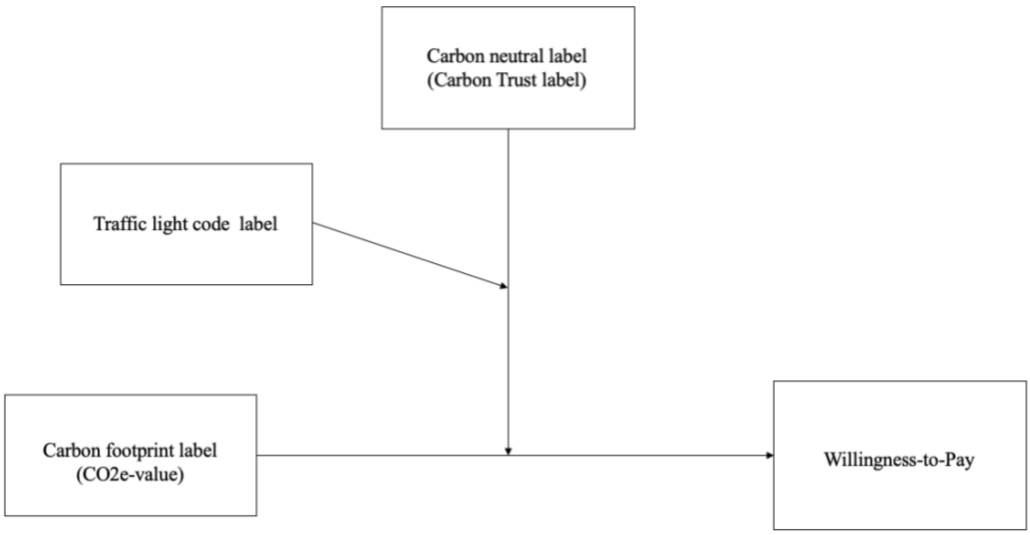


Figure 1: Conceptual framework for the effect of carbon neutral labels, traffic light code labels and carbon footprint label on the WTP

To determine the impact of the three carbon labels, individually and in combination, on WTP, an online experiment is conducted that directly asks participants about their WTP for certain food products. Given that the individual carbon labels have different attributes, it is particularly important to examine how differently these affect the WTP. Beyond that, personal questions such as demographics are queried and questions about social identity (carbon offsetter and pro-environmental) and pro-environmental intentions are measured, allowing a refined picture of the participants to be sampled. It would be of valuable importance, especially in the context of managerial implications (e.g., target group-oriented communication) and label design, how the critical factor trust of the individual labels is rated. In addition, participants are asked about their dietary behavior to be able to conclude how (un)sustainable, in the sense of for instance

meat consumption, the diet of a person is. At this point, it is interesting to see whether there are differences between the various groups (according to demographics, trust, social identity, environmental concern) on the WTP.

3. Methodology & Data Collection

This chapter presents the methodology of this research and illustrates how data was collected through an online experiment, how the independent variables were manipulated, how the dependent and control variables were measured, and finally analyzed.

3.1 The Sample

The questionnaire was filled out by 169 respondents over a duration of 13 days, whereas 121 submitted fully usable data of whom 43% (n = 52) referred to being male, 56,2 (n = 68) female and 0.8% (n = 1) non-binary / third gender.

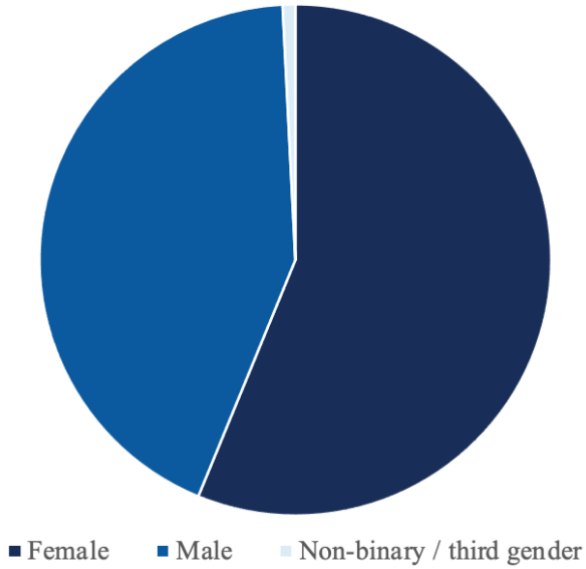


Figure 2: Gender

The average age of the inquired group was 29.6 years (SD = 9.79), ranging from 15-to-70 years. As shown in figure 3, most participants are in their 20s, with most people (23) being 27 years old.

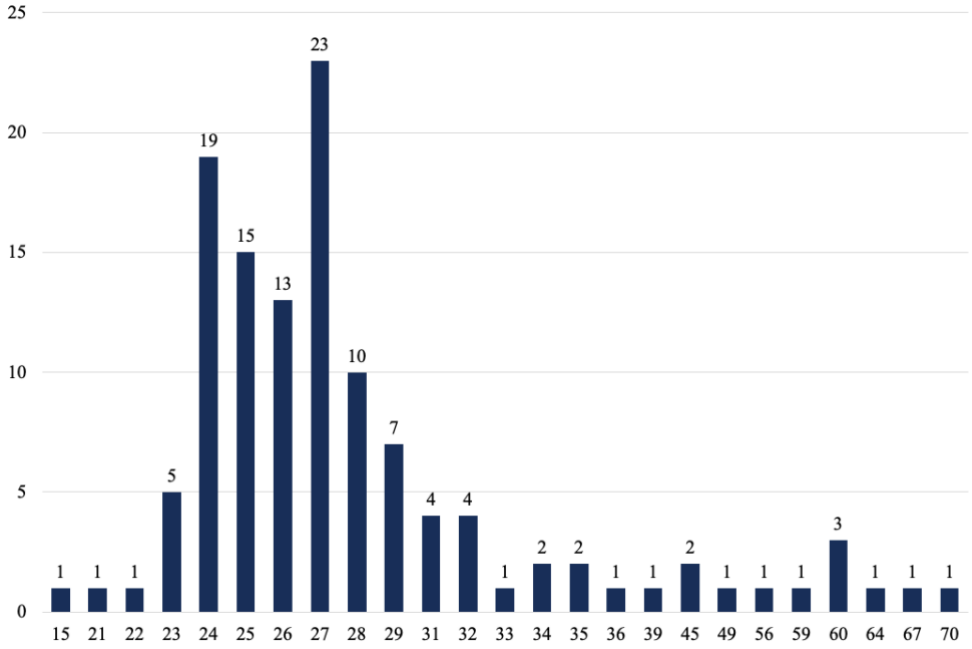


Figure 3: Distribution of Age

More than 82.7 % of all participants stated to hold a university degree, whereas about 49 % indicated to graduate with a master's degree (n = 59) and about 33 % with a bachelor's degree (n = 40). The remaining participants hold either a doctorate, less than High School or High School degree and two participants preferred not to say.

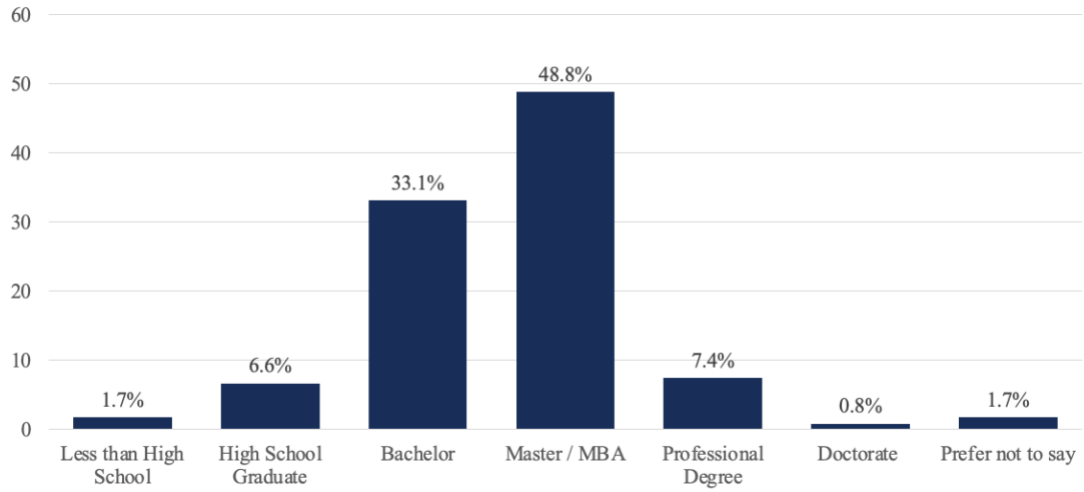


Figure 4: Level of Education

In total, people from 10 different nations worldwide participated, even though more than half of them (66.9 %; n = 81) were Germans, the second largest group being in Portugal (23.1 %; n = 28) and the rest were from Switzerland, Mexico, Italy, Israel, France, Denmark, and Afghanistan.

Participants were also asked about their monthly net income. More than half (57.9 %; n = 70) have an income between 1000€ and 3000€, followed by 26 people (21.5 %) having less than 1000€. Further, 17 indicated a net income of 3001€-5000€ (14%). The remaining three participants ranged between 5001€ and more and five preferred not to say (4.1%).

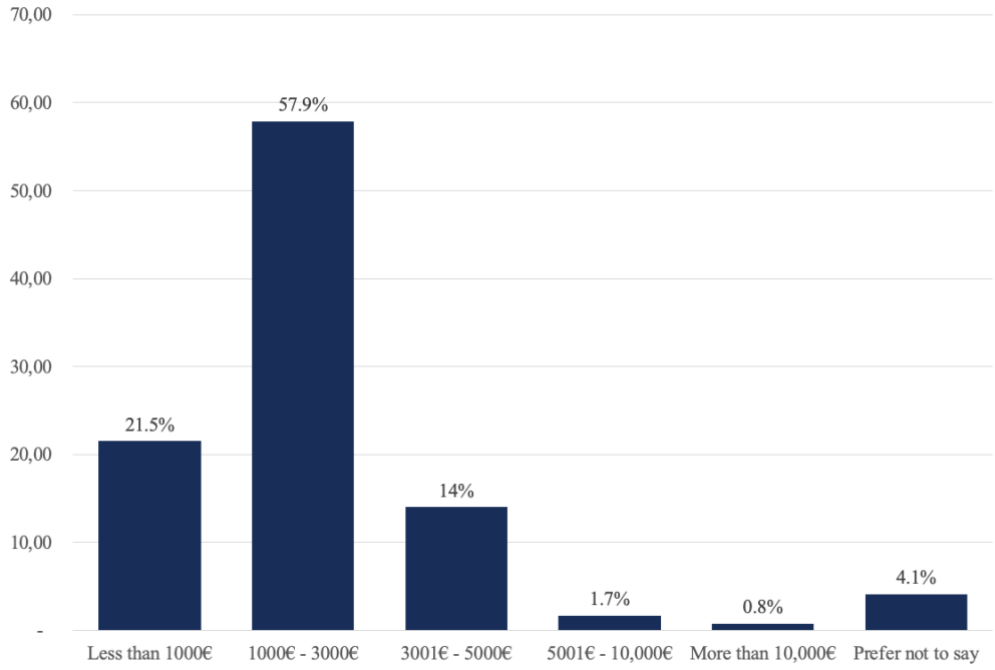


Figure 5: Monthly Net Income

Finally, dietary behavior was asked, with most participants being flexitarian, eating red meat, poultry, or fish less than once a week (n=53; 43.8%), followed by omnivorous eaters, eating meat or fish almost every day (n=22; 18.2%) and vegetarians (not consuming any meat or fish) (n=23; 19%). 10 people (8.3%) have a vegan diet, and 5 (4.1%) preferred not to say.

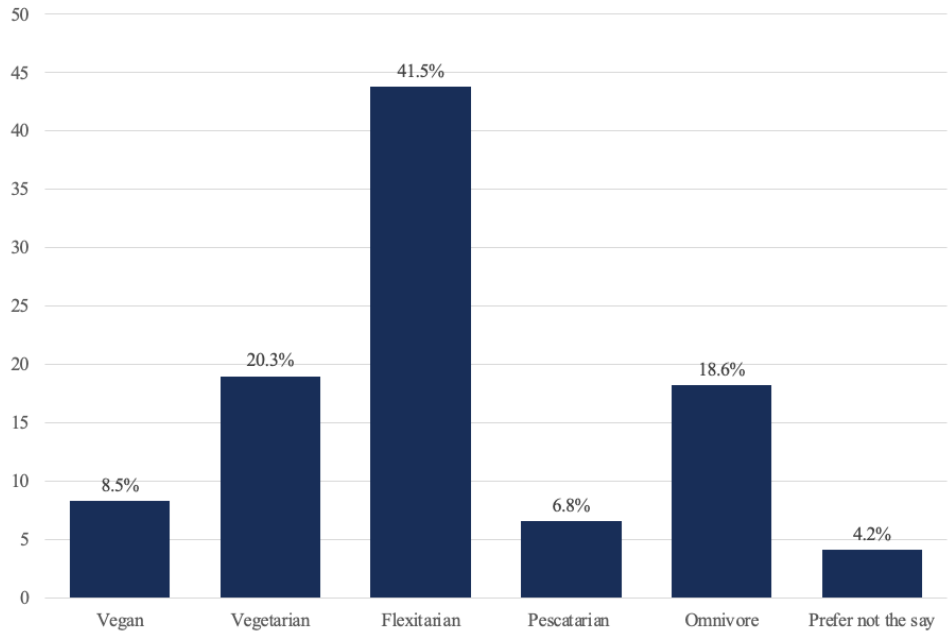


Figure 6: Diet Behavior

3.2 The Survey and Experiment

In this thesis, explanatory and experimental methods were applied to collect the relevant data in the context of an online survey using Qualtrics®, the whole questionnaire can be found in Appendix 5. The survey was sent out on social media platforms (WhatsApp, Facebook, and LinkedIn), and via e-mail asking to further spread the survey to enlarge the sample size (snowball procedure) on November 11th,2021. After 10 days, the survey was closed with 138 responses.

3.3 Procedure, Survey Design and Measures

The questionnaire, which was approximately nine minutes long, contained 25 questions and was available in-browser and on mobile.

The experimental manipulation, which had a 2 (carbon neutral label vs. no label) x 2 (carbon footprint label vs. no label) x 2 (traffic light code label vs. no label) mixed factorial design, where carbon neutral labels and carbon footprint labels were manipulated between subjects. The traffic light code label was manipulated within-subjects, with random assignment for all conditions. The experimental conditions and their number of participants are therefore the following:

Group	Experimental Condition	N
1	Carbon Footprint	29
2	Carbon Neutral Label	29
3	Carbon Footprint and Carbon Neutral Label	29
4	No Carbon Footprint or Carbon Neutral Label	31

Table 1: Experimental Conditions

Thereby participants randomly rated 10 food products (beef, cheese, butter, a tomato, eggs, chicken, milk, rice, flour, and an apple) where half of these (beef, eggs, tomato, butter, and cheese) were manipulated with a traffic light code label. The experiment was briefly introduced with an explanatory text, stating that it was a simulation task. Then, the participants were shown 10 pictures of different food products, and they had to indicate their WTP for each product. To be able to reproduce the effect of the labels without adding other influencing variables, no other information (e.g., the brand) was given on the packaging. However, the average quantity in grams of the packaging or of the individual product was indicated.

After the manipulations, participants responded to the same catalog of questions. The three labels were asked about their familiarity and level of trust, followed by questions about the control variables environmental concern and social identity. To infer people's eating behavior, a question was asked about their dieting behavior. Finally, demographics were requested at the end. All questions were mandatory to answer, to be able to proceed.

3.3.1 Carbon Trust Label

According to Janssen and Hamm (2012) advise using well-known organic certification labels that consumers trust, four different labels were assessed, which can be seen in figure 2.

Figure 7: The Carbon Trust Carbon Neutral Labels
(Source: (Carbon Neutral Certification, 2020)

Due to the limitation of the work, the experiment focuses on one label. The label *Carbon Trust* is, next to the governmental verification on *Siegelklarheit*, verified by an independent sustainability platform *Utopia*. Thus, a governmental and an independent perspective is combined to obtain an objective evaluation. Furthermore, climate-neutral is stated on the label, which provides unambiguity and simplicity for understanding. Thus, in the current experiment participants were randomly assigned to either the carbon trust label conditions or the no carbon trust label conditions.

3.3.2 Carbon Footprint Label

The products were selected to cover the different product categories to represent diversity and were filtered according to the most frequently purchased products. Based on this, the products that were listed in a CO_2e-value table for food items (Appendix 7) were selected to calculate the CO_2-emission value per package serving. Due to the limitation of the exact calculation of the CO_2-emission value per food item, data from sources considered reliable and experts in their field (Appendix 7) were adopted. These include, for instance, the World Wide Fund for Nature (WWF) as one of the largest, internationally operating, non-governmental nature conservation organizations (WWF, 2021). The overall assessment, from the production to usage, is the reason to use data from the WWF's *Food in a warming world report* and *Climate*

change on your plate report to ensure the highest possible reliability and transparency. These used both governmental information (German Federal Ministry of Food, Agriculture and Consumer Protection) and other studies, which serve as a data basis to provide high credibility, realistic values, and objectivity of data. Similarly, to the carbon trust labels manipulation, participants were randomly assigned to either the carbon footprint label conditions or the no carbon footprint label conditions.

Figure 3 is an example of a CO_2e-value of a product, with the claim "Climate Footprint", which was used as it was found that CO_2 is difficult to understand and to aid comprehension. Furthermore, the reference value was scaled down to kilogram CO_2e per kilogram of food instead of per ton to make the relation more intelligible.

Figure 8: Carbon Footprint Label

(Source: Own illustration)

3.3.3 Traffic Light Code Label

For the reasons and on the recommendation of Emberger-Klein and Menrad (2018) to provide "additional climate-relevant information in a supermarket" to put the CO_2-emissions-value into relation and shift the focus on carbon labels, a traffic light code label was used. That way the communication of the carbon labels was modified. Based on a traffic light code system and the *Nutri-Score*, a nutritional label that translates the nutritional value of products into a code consisting of five letters (A to E) and 5 colors (Colruyt Group, n.d.), a traffic light code for food products was created.

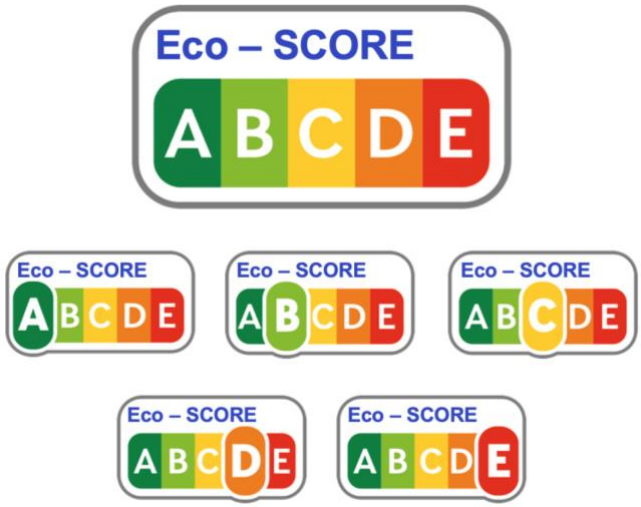


Figure 9: The Carbon Trust Label (Climate Neutral Label)

(Source: Own illustration based on (Colruyt Group, n.d.)

The label communicates the relative performance of the 10 shown products. As the *Nutri-Score* is already established on the EU food market a high and fast comprehension rate is expected, hence a high comprehension. In this case a range of five colors and letters (A to E) is used to illustrate ranges from low CO_2e (green), to high CO_2e (red), indicating the ecological impact (eco-score). The scale is divided by five from the maximum and minimum values given in Appendix 8. Participants were asked to rate 10 food products, in which half of them had traffic light code system whereas the other half had no traffic light code system.

To illustrate, figure 5 shows the 4 experimental conditions (manipulations). These were equally and randomly exposed to the participants.

Experimental Condition 1: Participants were exposed to a carbon neutral, carbon footprint and traffic light code label.	
Experimental Condition 2: Particpants were exposed to a carbon footprint and traffic light code label.	
Experimental Condition 3: Particpants were exposed to a carbon neutral and traffic light code label.	
Experimental Condition 4: Particpants were exposed to a traffic light code label.	
Example without a Traffic Light Code Label: Concerning half of the products in every condition	

Figure 10:Examples of the Experimental Conditions

3.3.1 Dependent Variables

3.3.1.1 WTP

To assess the WTP of the consumers, a hypothetical marketplace simulation with no actual transaction was made (Romano et al., 2016). As many studies found that consumers are willing to pay more for products with a sustainability label, participants were directly asked for their WTP. Therefore, a slider was used for each product. The price range was set as follows: the

average price of the product was taken with the lowest anchor on 0€ and the highest anchor on 50% above the average price (Appendix 9).

3.3.1.2 Trust

To test the familiarity of the labels, the dichotomous format with two options "yes" and "no" was used. Furthermore, trust of the three carbon labels is measured according to Janssen and Hamm (2012), who tested “Trust” on a 5-point Likert scale ranging from (1) “I completely trust this label.” to (5) “I do not trust this label at all”.

3.3.2 Control Variables

After the experiment, participants were asked about their environmental concerns and social identity with respect to sustainability. For this purpose, the item statements were randomized, to control for bias.

Environmental Concern

Environmental concern was measured according to Thøgersen et al. (2010) environmental concern was measured by using a 5-point Likert scale with the endpoints (1) “strongly disagree” and (5) “strongly agree”. This measurement was adapted for the statements shown in Appendix 5. The environmental concern scale showed overall a good reliability index, Cronbach’s α = .88 indicating that the construct has good internal consistency.

Social identity

Social identity was adapted according to Whitmarsh and O’Neill (2010) to address carbon offsetting and pro-environmental intentions, and was measured on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The seven questions (Appendix 5) about carbon offsetting are structured into positive (4 items) and negative (3 items) attitudes to control for bias by polarity.

Furthermore, the carbon offsetter subscale showed reliability index of a Cronbach's α = .666, indicating that the construct has almost an acceptable internal consistency. However, the "carbon offsetting is a waste of time" carbon offsetter subscale had a questionable Cronbach's α= .588. The low values can be explained by the fact that, as described in chapter 1, consumers lack an understanding of the issues surrounding CO_2. Despite the enclosed information on what carbon offsetting means, the values were far below the acceptable level. This may indicate that there is a very high need for clarification so that brief information was not sufficient to answer the carbon offsetter statements based on that.

Regarding the pro-environmental intention subscale of social identity, two reversed statements were included, which can be seen in Appendix 5. The pro-environment subscale showed an acceptable reliability index, Cronbach's α = .711 indicating that the construct has acceptable internal consistency.

3.3.3 Demographics

Finally, participants are asked to answer six questions about demographics: diet behavior, gender, age, country of residence, education, and monthly net income. Whilst diet behavior, gender, age, country of residence and education were measured on a nominal scale, the monthly net income was assessed on an ordinal scale by giving answer options with intervals. Regarding the diet behavior subjects were classified into different dietary groups based on information from the dietary questionnaire of Clarys et al., (2014): vegan (no animal products), vegetarian (no meat or fish), flexitarian (red meat, poultry, or fish no more than once a week), pescatarian (no meat, but fish), omnivore (meat or fish almost daily) and prefer not to say.

4. Data Analyses

This chapter provides the data analyses of this research and aims to reach conclusions for the previously examined research questions and test the hypotheses.

To obtain a clean data set, data cleaning was performed. Therefore, non-complete answers were deleted and edited to prepare the data set for the analyses. For instance, environmental concern and social identity were reverse coded variables and were inverted to be able to deduce reasonable results. All data gathered through the questionnaire was analyzed using IBM SPSS Version 26 statistics software.

4.1 Descriptive Analysis and Normality Test

In this analysis four essential indicators (mean, standard deviation, kurtosis, and skewness) are used for the descriptive analysis.

Willingness to Pay

Table 2 shows the means of the WTP within subjects separated by the experimental conditions as shown in Table 2. It can be observed that group 3 (30.54 €) had the highest average WTP of all summed WTP for all products, followed by group 1 (27.16 €), then group 2 (26.2 €) and lastly group 4 (23.19 €). Adding to that, group 3 again has the highest means for almost every product, besides butter, milk, rice, and apple. Regarding the Skewness and Kurtosis, every value has an even distribution, as the values do not exceed -/+ 1. Moreover, it is noticeable that the standard deviation is highest in all groups for meat, such as chicken, and especially for beef steak. Whereas the values for tomato and apple are the lowest. This shows that WTP deviates further from the mean at the high values.

		Product	Minimum	Maximum	Sum	Mean	Std. Deviation	Skewness		Kurtosis	
								Statistic	Std. Error	Statistic	Std. Error
Group 1	Carbon Footprint Label	Beef steak	2,20 €	25,00 €	334,60 €	10,79 €	5,392	0,654	0,421	0,379	0,821
		Cheese	0,50 €	4,00 €	69,50 €	2,40 €	0,893	0,269	0,434	-0,095	0,845
		Butter	0,60 €	4,00 €	59,30 €	2,04 €	0,812	0,682	0,434	0,787	0,845
		Tomato	0,10 €	1,00 €	11,10 €	0,38 €	0,187	1,356	0,434	2,924	0,845
		Eggs	1,00 €	4,00 €	72,00 €	2,48 €	0,841	0,067	0,434	-0,951	0,845
		Chicken	1,10 €	6,00 €	132,90 €	4,58 €	1,572	-0,799	0,434	-0,527	0,845
		Milk	- €	2,00 €	42,60 €	1,47 €	0,498	-1,014	0,434	1,126	0,845
		Rice	0,20 €	2,00 €	36,70 €	1,27 €	0,384	-0,591	0,434	1,325	0,845
		Flour	0,50 €	2,00 €	36,00 €	1,24 €	0,469	0,529	0,434	-0,775	0,845
		Apple	0,10 €	1,00 €	14,40 €	0,50 €	0,265	0,225	0,434	-1,005	0,845
Group 2	Carbon Neutral Label (Carbon Trust Label)	Beef steak	- €	25,00 €	296,20 €	10,21 €	6,761	0,724	0,434	-0,330	0,845
		Cheese	1,00 €	4,00 €	70,90 €	2,44 €	0,803	0,016	0,434	-0,731	0,845
		Butter	- €	4,00 €	52,90 €	1,82 €	0,930	-0,004	0,434	0,012	0,845
		Tomato	0,10 €	1,00 €	11,60 €	0,40 €	0,224	0,721	0,434	0,318	0,845
		Eggs	- €	4,00 €	67,70 €	2,33 €	0,871	-0,628	0,434	1,394	0,845
		Chicken	- €	6,00 €	123,10 €	4,24 €	1,533	-0,855	0,434	0,464	0,845
		Milk	- €	2,00 €	41,50 €	1,43 €	0,487	-0,679	0,434	0,867	0,845
		Rice	0,80 €	2,00 €	41,20 €	1,42 €	0,371	0,141	0,434	-1,030	0,845
		Flour	0,50 €	3,00 €	41,90 €	1,44 €	0,541	0,759	0,434	0,935	0,845
		Apple	0,10 €	1,00 €	12,80 €	0,44 €	0,244	0,712	0,434	0,152	0,845
Group 3	Carbon Footprint Label and Carbon Neutral Label	Beef steak	- €	25,00 €	381,70 €	13,16 €	7,217	0,095	0,434	-0,872	0,845
		Cheese	0,90 €	4,00 €	72,70 €	2,51 €	0,788	-0,030	0,434	-0,338	0,845
		Butter	0,50 €	4,00 €	54,80 €	1,89 €	0,815	0,622	0,434	0,250	0,845
		Tomato	0,20 €	1,00 €	12,50 €	0,43 €	0,214	0,857	0,434	0,325	0,845
		Eggs	1,20 €	4,00 €	76,70 €	2,64 €	0,706	-0,372	0,434	-0,050	0,845
		Chicken	- €	6,00 €	146,10 €	5,04 €	1,324	-2,182	0,434	6,470	0,845
		Milk	- €	2,00 €	43,60 €	1,50 €	0,508	-1,030	0,434	1,134	0,845
		Rice	0,50 €	2,00 €	39,60 €	1,37 €	0,422	-0,118	0,434	-0,723	0,845
		Flour	0,70 €	3,00 €	43,70 €	1,51 €	0,590	0,938	0,434	0,429	0,845
		Apple	0,20 €	1,00 €	14,20 €	0,49 €	0,209	0,448	0,434	-0,161	0,845
Group 4	No Carbon Footprint or Carbon Neutral Label	Beef steak	- €	24,30 €	251,50 €	8,11 €	5,203	0,817	0,421	1,789	0,821
		Cheese	- €	3,50 €	69,40 €	2,24 €	0,828	-0,823	0,421	0,556	0,821
		Butter	- €	2,90 €	48,90 €	1,58 €	0,641	0,113	0,421	0,269	0,821
		Tomato	0,10 €	1,00 €	12,00 €	0,39 €	0,222	1,547	0,421	2,285	0,821
		Eggs	1,00 €	4,00 €	79,10 €	2,55 €	0,782	-0,425	0,421	-0,736	0,821
		Chicken	- €	6,00 €	115,30 €	3,72 €	1,620	-0,669	0,421	0,167	0,821
		Milk	0,80 €	2,00 €	47,10 €	1,52 €	0,360	-0,292	0,421	-0,827	0,821
		Rice	0,50 €	2,00 €	40,20 €	1,30 €	0,422	0,067	0,421	-0,727	0,821
		Flour	0,50 €	3,00 €	41,30 €	1,33 €	0,599	0,716	0,421	0,656	0,821
		Apple	0,20 €	1,00 €	14,20 €	0,46 €	0,206	0,657	0,421	0,092	0,821

Table 2: Statistical Descriptive of the WTP per Experimental Condition

Table 3 shows the WTP in comparison to the average German market prices for the tested food products per serving. It is striking that groups 1 to 3, the presence of one or more labels, show above-average WTP for four products each. Especially for animal-based products such as cheese, chicken and milk, the means are well above the average price. For example, the values for chicken (4.58 €, 4.24 €, 5.04 € and 3.72 €) are at least three times higher than the average market price (1.04 €).

		Product	Mean	Average Market Prices
Group 1	Carbon Footprint Label	Beef steak	10,79 €	17,00 €
		Cheese	2,40 €	2,35 €
		Butter	2,04 €	2,10 €
		Tomato	0,38 €	0,13 €
		Eggs	2,48 €	2,76 €
		Chicken	4,58 €	1,04 €
		Milk	1,47 €	0,88 €
		Rice	1,27 €	1,50 €
		Flour	1,24 €	1,58 €
		Apple	0,50 €	0,50 €
Group 2	Carbon Neutral Label (Carbon Trust Label)	Beef steak	10,21 €	17,00 €
		Cheese	2,44 €	2,35 €
		Butter	1,82 €	2,10 €
		Tomato	0,40 €	0,13 €
		Eggs	2,33 €	2,76 €
		Chicken	4,24 €	1,04 €
		Milk	1,43 €	0,88 €
		Rice	1,42 €	1,50 €
		Flour	1,44 €	1,58 €
		Apple	0,44 €	0,50 €
Group 3	Carbon Footprint Label and Carbon Neutral Label	Beef steak	13,16 €	17,00 €
		Cheese	2,51 €	2,35 €
		Butter	1,89 €	2,10 €
		Tomato	0,43 €	0,13 €
		Eggs	2,64 €	2,76 €
		Chicken	5,04 €	1,04 €
		Milk	1,50 €	0,88 €
		Rice	1,37 €	1,50 €
		Flour	1,51 €	1,58 €
		Apple	0,49 €	0,50 €
Group 4	No Carbon Footprint or Carbon Neutral Label	Beef steak	8,11 €	17,00 €
		Cheese	2,24 €	2,35 €
		Butter	1,58 €	2,10 €
		Tomato	0,39 €	0,13 €
		Eggs	2,55 €	2,76 €
		Chicken	3,72 €	1,04 €
		Milk	1,52 €	0,88 €
		Rice	1,30 €	1,50 €
		Flour	1,33 €	1,58 €
		Apple	0,46 €	0,50 €

Table 3: WTP in Comparison to Average Market Prices

Trust

Figure 11 shows the frequencies participants indicating “yes” or “no” to the familiarity of the tested labels. Therefore, the traffic light code label was known the most (Yes, n = 91; 75.2%; No, n = 30; 24.8%). In contrast the carbon footprint (Yes, n = 22; 18.2%; No, n = 99; 81.8%) and the carbon neutral label (Yes, n = 47; 38.8%; No, n = 74; 61.2%) were less familiar.

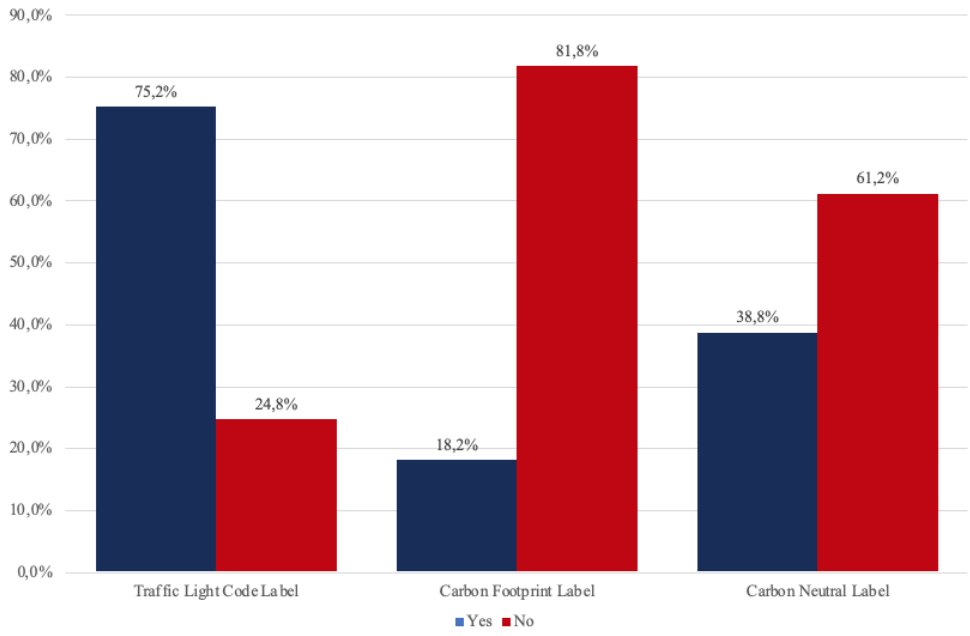


Figure 11: Familiarity of the Carbon Labels

To compare the level of trust of the three labels a one-Way ANOVA (repeated measures) was conducted to be able to display a mean comparison (Table 4). It is clearly displayed that the carbon neutral label was most trusted by the participants, followed by the traffic light code and lastly the carbon footprint label. All in all, all labels are more trusted than distrusted, as on a scale of 5 the grand means is 3.116 and this is higher than 2.5.

	N	Mean	Std. Deviation
Traffic Light Code Label	121	3,06	,788
Carbon Footprint Label	121	2,83	.869
Carbon Neutral Label	121	3,45	1,057

Table 4: Descriptive Statistics of the Level of Trust

Social identity

To analyze the social identity as a carbon offsetter (Table 5) and pro-environmental intentions (Table 6) descriptive statistics are illustrated below. First, it can be remarked that all values in both tables are relatively high, namely all values are above 2.5 (on a scale up to 5). Furthermore, both Skewness and Kurtosis of both tables display an even distribution, as the values do not exceed -/+ 1.

	N	Mean	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
I trust companies offering carbon offsetting to use the money I paid in the right way.	121	3,09	0,931	-0,183	0,22	-0,718	0,437
Carbon offsetting will make no difference in the fight against climate change.	121	4,03	0,991	-1,164	0,22	1,091	0,437
Carbon offsetting is a way to quickly and easily tackle climate change.	121	3,26	0,945	-0,657	0,22	0,305	0,437
Carbon offsetting can help reduce unavoidable emissions.	121	3,72	1,09	-0,873	0,22	0,318	0,437
Carbon offsetting should be mandatory.	120	3,78	1,022	-0,511	0,221	-0,429	0,438
Carbon offsetting is a waste of time.	119	4,21	0,938	-1,187	0,222	0,898	0,44
Carbon offsetting encourages people to carry on doing things that harm the environment.	119	2,83	1,076	0,301	0,222	-0,431	0,44

Table 5: Descriptive Statistics of the Social Identity as a Carbon Offsetter

	N	Mean	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
I think of myself as someone who is very concerned with environmental issues.	121	3,65	1,022	-0,685	0,22	0,193	0,437
I think of myself as an environmentally-friendly consumer.	121	3,49	1,05	-0,428	0,22	-0,338	0,437
I would be embarrassed to be seen as having an environmentally friendly lifestyle.	121	4,58	0,938	-2,637	0,22	6,559	0,437
I would not want my family or friends to think of me as someone who is concerned about environmental issue.	121	4,5	1,001	-2,115	0,22	3,595	0,437

Table 6: Descriptive Statistics of the Pro-Environmental Intentions

Environmental Concern

Again, all means are above the value of 2.5 (on a scale of 5), indicating that on average all participants have a high value in environmental concern. Looking at the Skewness and Kurtosis values an even distribution can be seen.

	N	Mean	Std. Deviation	Skewness		Kurtosis	
				Statistic	Std. Error	Statistic	Std. Error
I am concerned about the development of the global environment.	121	4,42	1,101	-1,396	0,22	2,686	0,437
I feel it is a moral obligation to use environment-friendly products.	121	3,95	1,189	-0,84	0,22	0,719	0,437
It concerns me that people do not care enough for the environment.	121	4,17	1,16	-0,77	0,22	0,79	0,437
I often buy eco-labeled products for the sake of the environment.	121	3,86	1,254	-0,349	0,22	-0,172	0,437

Table 7: Descriptive Statistics of the Environmental Concern

4.2 Hypotheses Testing

A general linear model (GLM) repeated measures was conducted to test the initial hypothesis. The WTP was entered as the dependent variable, carbon trust label (vs. no label) and carbon footprint label (vs. no label) were entered as between-subjects factors, and traffic light code system (vs. no traffic light code system) was introduced as the within-subjects factor. Additionally, pro-environmental and carbon offsetter for social identity and environmental concern were included as control variables.

Looking at table 8, the mean increases as soon as a label is added and reaches the highest value when all labels are present. On the contrary, when no label is present, the mean for the WTP is lowest. This shows, considering the means, that the labels have a positive impact on the WTP.

	Carbon Neutral Label	Carbon Footprint Label	Mean	Std. Deviation	N
Traffic Light Code label	No	No	2,9735	1,20447	31
		Yes	3,6683	1,29128	29
		Total	3,3093	1,28513	60
	Yes	No	3,4434	1,69228	29
		Yes	4,1269	1,54369	29
		Total	3,7852	1,64201	58
	Total	No	3,2007	1,46726	60
		Yes	3,8976	1,4294	58
			3,5432	1,4844	118
No Traffic Light Code Label	No	No	1,6652	0,46972	31
		Yes	1,811	0,52018	29
		Total	1,7357	0,49599	60
	Yes	No	1,7966	0,46798	29
		Yes	1,9807	0,46317	29
		Total	1,8886	0,47073	58
	Total	No	1,7287	0,46958	60
		Yes	1,8959	0,49561	58
			1,8108	0,48776	118

Table 8: Descriptive Statistics of the ANCOVA Analysis

Main Effects

Results revealed that the main effect of traffic light code on the WTP was not statistically significant (F (1, 111) = .006, p = .941, $\eta p2$ = .000). The main effect of carbon neutral label was also not statistically significant (F (1, 111) = 3.85, p = .052, $\eta p2$ = .033). However, the main effect of carbon footprint label was statistically significant (F (1, 111) = 7.79, p = .006, $\eta p2$ = .066).

Interaction Effects

Moreover, it can be said that the interaction effects of the traffic light code label in combination with the carbon neutral label on the WTP was not statistically significant (F (1, 111) = 2.251, p = .136, $\eta p2$ = .020), whereas the traffic light code label with the carbon footprint label was statistically significant (F (1, 111) = 6.557, p = .012, $\eta p2$ = .056). Thus, the second significant effect on the WTP is obtained. Having a look at the combination of all three carbon labels shows that there is no significant interaction effect (F (1, 111) = .041, p = .840, $\eta p2$ = .000).

Covariates

The covariates for this analysis were ”Pro-environment” (F (1, 111) = 1.304, p = .256, $\eta p2$ = .012), “Carbon Offsetter” (F (1, 111) = .681, p = .411, $\eta p2$ = .006) and “Environmental Concern” (F (1, 111) = .216, p = .643, $\eta p2$ = .002), which show no statistically significant effect

on the WTP on their own. Regarding their interaction effect with a carbon labels, results are as follow: There was no statistically significant effect of the traffic light code label and the covariate pro-environment (F (1, 111) = .551, p = .460, $\eta p2$ = .005), also not in combination with the second social identity covariate carbon offsetter (F (1, 111) = 3.550, p = .062, $\eta p2$ = .031), nor the traffic light code label and environmental concern (F (1, 111) = .167, p = .684, $\eta p2$ = .002) on the WTP. Therefore, no covariate had a significant effect on the WTP as all p-values are > 0.05.

Comparison of the Means

The GLM reseated measures analysis reveals that the carbon footprint label alone (0.006) and in combination with the traffic light code label (.012) have a statistically significant effect on the WTP for food products. The test of between-subjects effects reveals that the carbon footprint label has a significant mean (M = 2.912, SE = .116, p = .006), whereas adding the traffic light code label to the carbon footprint label results in a mean of 3.924 (SE = .188, p = .012). The single carbon footprint label has the highest statistically significant mean on the WTP.

Regarding the estimates of the effect size (Partial Eta Squared) the carbon footprint label has the strongest ($\eta p2$ = .066) and in combination with the traffic light code label the second strongest ($\eta p2$ = .056) effect on the WTP.

In summary, these findings suggest that the carbon footprint label alone (H2) and in combination with the traffic light code label (H6) had a positive significant impact, by increasing the WTP.

5. Conclusion

The purpose of this thesis was filling the research gap of carbon labels by exploring how they affect consumers' WTP. Chapter 5 aims to draw a conclusion of the research topic by pointing out the limitations and formulating recommendations for further research.

5.1 Discussion

The overall goal of this thesis was to identify the impact of three carbon labels: carbon footprint, carbon neutral (from Carbon trust) and the traffic light code label on the WTP for food products. Furthermore, it was intended to address the food industry. Through an online experiment, the participants were randomly exposed to one of four possible conditions. This allowed a comparison of the outcomes of the four conditions. Furthermore, the effect of the carbon labels on the WTP was investigated.

Based on the literature review, where it was predicted that carbon labels had a primarily positive impact on the WTP (RQ1). The main goal of this study was to prove that the three carbon labels have a significant positive impact, namely a higher WTP.

This research shows that the carbon footprint label has a significant impact on the WTP, which is amplified by the traffic light code label. This suggests that a numerical carbon footprint adds to the understanding of the environmental impact of a food product and influences the purchase decision (RQ2). Particularly outstanding is the effect of the combination of two label systems, the traffic light code and carbon footprint label. The results reflect an increased awareness of the participants about the impact of the food product, who are willing to pay more. One reason for this could be that the issue was addressed, as Camilleri et al. (2019) found, that people do lack of knowledge and skills to make CO_2e estimates of food products. In addition, Feucht and Zander (2017) recommended to communicate carbon labels clearly and understandable. Providing the exact CO_2e-values as information clarifies the impact numerically, making the carbon footprint of a food product clear and tangible. Its impact becomes even more comprehensible by adding a traffic light code label, which puts the CO_2e-value into perspective. Therefore, the awareness of the impact increases, which in turn affected the participant's behavior. Regarding the carbon-neutral label, it can be concluded that the label "climate neutral" is not sufficiently informative and therefore its role can be disguised.

However, it is noticeable that the carbon footprint label had a significant impact on WTP, which was amplified by the traffic light label, suggesting that a numerical number adds to the understanding of the environmental impact of a food product and influences the decision (RQ2). This could be an indication that the CO_2e-value was communicated in an easier and intelligible way by putting the concrete CO_2e-value into relation, which confirms the results of Leira & Thidell 2005; Röös & Tjärnemo, 2011; Feucht & Zander, 2017; Camilleri et al., 2019. In this case, trust in the label and awareness seems to have less influence on the WTP.

Nevertheless, there was no statistically significant effect of the carbon neutral and traffic light code label alone and neither of social identity nor environmental concern. This may be due to multiple reasons. First, carbon labels are still relatively new on the market, which was confirmed by the question of familiarity for the labels. Except for the traffic light code label, the other two labels are clearly unknown (carbon footprint label = 81.8%; carbon neutral label = 61.2%) than known. Therefore, the unfamiliarity may have an impact on the inclusion and consideration of the labels in the purchase decision. Although most people were not aware of the carbon footprint label, it had a significant impact on the WTP. Thus, Hanss and Böhm's (2012) findings cannot be confirmed, as they argue that labels should be known to people to incentivize them to buy.

Unfamiliarity may also have affected trust in the labels, with carbon footprint labels being the least, and the carbon neutral label being the most trusted. This could be due to the authenticity of the labels respectively the design since the original carbon trust label was used, while the other labels were imitated. Regarding the familiarity of the traffic light code, it can be concluded that it is close in design to the nutrition label that is established in the EU. Since the system of a traffic light and the design are well known, the high number of familiarities could be justified. In addition, the level of trust in this label is higher than that of the carbon footprint label, which could also be attributed to the familiarity of the nutrition Label.

Similarly, it can be said that less available information (such as group 4: no carbon label or carbon-neutral label) leads to less information-based decisions resulting in a lower WTP. The statistical analysis shows that the carbon-neutral label, with no numerical information had the lowest incline in mean (+.320). This might indicate that it did not add informative value to an information-based purchase decision. What is striking here is that the participants were on average less willing to pay for CO_2e compensation (carbon neutral).

Furthermore, the significant results confirm that a decision aid in the form of a traffic light code label is helpful, which is consistent with previous research of Emberger-Klein and Menrad (2018) and confirms it. Also, the assumption of previous studies is confirmed, that an intelligible communication of the CO_2-value (here in combination with traffic light code labels), set in relation, has positive effects. Through the increased WTP, it can be concluded that the product appears more valuable, due to the additional attribute (putting the CO_2-emissions-value into relation) as well as the CO_2-emissions-value itself.

The key findings are that the carbon footprint label in combination with the traffic light code label has the strongest significant effect. As this is in line with the previous literature review, the conclusions can be applied to the general food industry. The advice of Emberger-Klein and Menrad (2018) to use a traffic light code label was followed and its effectiveness was proven.

5.2 Recommendations and Managerial Implications

This research proved that carbon footprint labels showed a significant positive impact, meaning that participants were willing to pay more. Hence, this type of label should be pursued further, emphasizing the work of pioneering companies such as Oatly who are working to mandate CO_2-emission disclosure on food products. The greatest effect was achieved in combination with the traffic light code label, which is why it is recommended to claim products with the numerical CO_2e value and put them in relation as well. A strong effect was seen especially for beef steak, cheese, or chicken (table 2). Especially this is an advantage to reduce the sales of environmentally harmful products, incentivize companies to at least compensate CO_2e-emissions and to create more awareness for critical products as meat.

Further, no statistically significant impact on the increase of the WTP for the carbon neutral label and the sole traffic light code label could be found. The reason for this could lie in the fact that the labels are relatively new, and the design of the labels (carbon footprint and traffic light code label) was mimicked (for manipulation), which could have affected the authenticity and the credibility or trust, representing a limitation to achieve a positive effect on the WTP. Despite this, an increase could be observed in all cases, thus it is suggested to use a professional design or a real label.

According to this study, consumers are even willing to pay more than the average price for many products (e.g., chicken, cheese, milk), which shows that products are perceived as more valuable (table 3). Adding to that the incline in WTP for a beefsteak raised tremendously by adding a carbon foot and traffic light code label. As it was criticized before that a change in the consumption behavior and consumption of food is necessary, this finding contributes to the fact that a price increase with a simultaneously quality increase (which mostly leads to a price increase) of the critical products (mainly animal products) is justifiable. Moreover, a CO_2-value claim obligation could pressure companies to produce more sustainably to reduce the GHGe of the food industry.

Finally, labels seem to be a small intervention with a great impact to promote climate-friendly and sustainable consumption, as their effect extends to many stakeholders (consumers, society, companies, environment, and governments). Their impact (educational and awareness-raising) can spread from the point of sale to the people's minds to create awareness for the environmental impact of food products consumption. Especially for companies and marketing departments labels prove to be an effective measure to promote sustainable consumption. Even if e.g., the CO_2e-measurement would mean additional effort, this study proves that a higher price could compensate this, as the willingness to pay above the average price is given.

It should also be emphasized that, based on this study, participants are willing to pay even more for environmentally critical products as animal-based products (e.g., chicken). These could be insights that are not only interesting on a marketing level, but also on a political level to promote sustainable consumption.

Nevertheless, carbon labels are interventions that constitute a fragment of a large construct or strategy to promote sustainable consumption, to achieve a shift and acceptance of consumers.

5.3 Limitations

The present study has limitations in the research that must be taken into consideration.

First, the sample is a limitation that is restricted by the author's network and is not representative for the population of Germany. To begin with, most participants are in their 20s and mainly hold a university degree (33.1% bachelor; 48.8% master /MBA), which is cumulatively (81.9%) representative for Germans in general. However, according to statistics of the German federal statistical office every second German has a bachelor's degree (Statistisches Bundesamt, 2021), whereas the sample predominantly holds a master's degree. Additionally, most have a relatively low to slightly above average (cumulated 79.4% have a net income of less than 1000€ - 3000€) net average income, which also cannot be transferred to the public. As the average net income of Statista (2021a) reveals, that Germans earn an average net income of 3580 in 2019. Therefore, the research applied to the demographics of the sample, and it is suggested to conduct the study on a larger and less homogeneous sample. Moreover, the groups of the experiment are not equal in size, as of the data cleaning process.

Furthermore, the carbon footprint and the traffic light code label design were imitated by the author to be able to manipulate them for the experiment. Since trust can be influenced by a good design, this represents a possible negative constraint.

In addition, the experiment did not use original product designs, including e.g., the brand, as this would impede the traceability of the labels' impact (attributes would compete against each other on the packaging design) and would bias the consumer. Therefore, future research should conduct field experiments, where real-life situations are imitated, e.g., in a supermarket, to test the impact and to contribute to the findings of this study.

5.4 Further Findings and Future Research

This chapter lists additional interesting findings that do not belong to this research, but that would have the potential to be pursued in more detail.

First, the study examined the WTP in the context of the simulation experiment, meaning that it was assumed that the displayed product is purchased. At this point it would be interesting to test another possibility, namely the purchase intention. Thus, it can be tested whether the labels even influence the purchase volume of e.g., meat.

Secondly, the examined GHG CO_2 is only one of six GHG. Further research could be extended to the other GHGe (as the actual more harmful GHG methane) as soon as the communication and measurement of these are possible and/or common. Secondly, only the impact on WTP was measured, hence further research could explore what was determining the WTP. This would require a more detailed consumer survey asking, for example, about label design or deeper questions about consumer's understanding of them.

Considering the SHIFT framework, it is recommended by White et al. (2019) concerning feelings and cognition to include emotions such as pride but also guilt to engage in sustainable behavior. This is also confirmed by Höijer (2010), who found that hope and compassion as a message aid in understanding climate change. This additional information and amplification of the carbon labels would be a further step and research to boost sustainable consumption even more.

A closer look at the demographics (table 9) shows that most women follow a vegan, vegetarian, or flexitarian diet, while most men consume meat (twice as much as women). This phenomenon is called the eco-gender gap (Hunt, 2020), which would be worthy to study, as it can have essential implications for targeted marketing and communication measurements.

	Female	Male	Non-binary / Third gender	Total
Vegan	8 6,6%	2 1,7%	0 0,0%	10 8,3%
Vegetarian	13 10,7%	10 8,3%	0 0,0%	23 19,0%
Flexitarian	35 28,9%	17 14,0%	1 0,8%	53 43,8%
Pescatarian	4 3,3%	4 3,3%	0 0,0%	8 6,6%
Omnivore	7 5,8%	15 12,4%	0 0,0%	22 18,2%
Prefer not to say	1 0,8%	4 3,3%	0 0,0%	5 4,1%
Total	68	52	1	121

Table 9: Gender and Diet Behavior in Relation

Lastly, appendix 10 displays an overview of how much the participants were willing to pay on average for the shown items, broken down to their dieting behavior. It should be noted that on average vegans and pescatarians had the most means with the highest average. Likewise, in each condition vegetarians and vegans are willing to pay more, whereas meat-eaters (omnivores and flexitarians) would pay the least on average, not even for meat products. Reasons for this could include differences in awareness for environment, animals, and health. These might also be further studied for further research purposes.

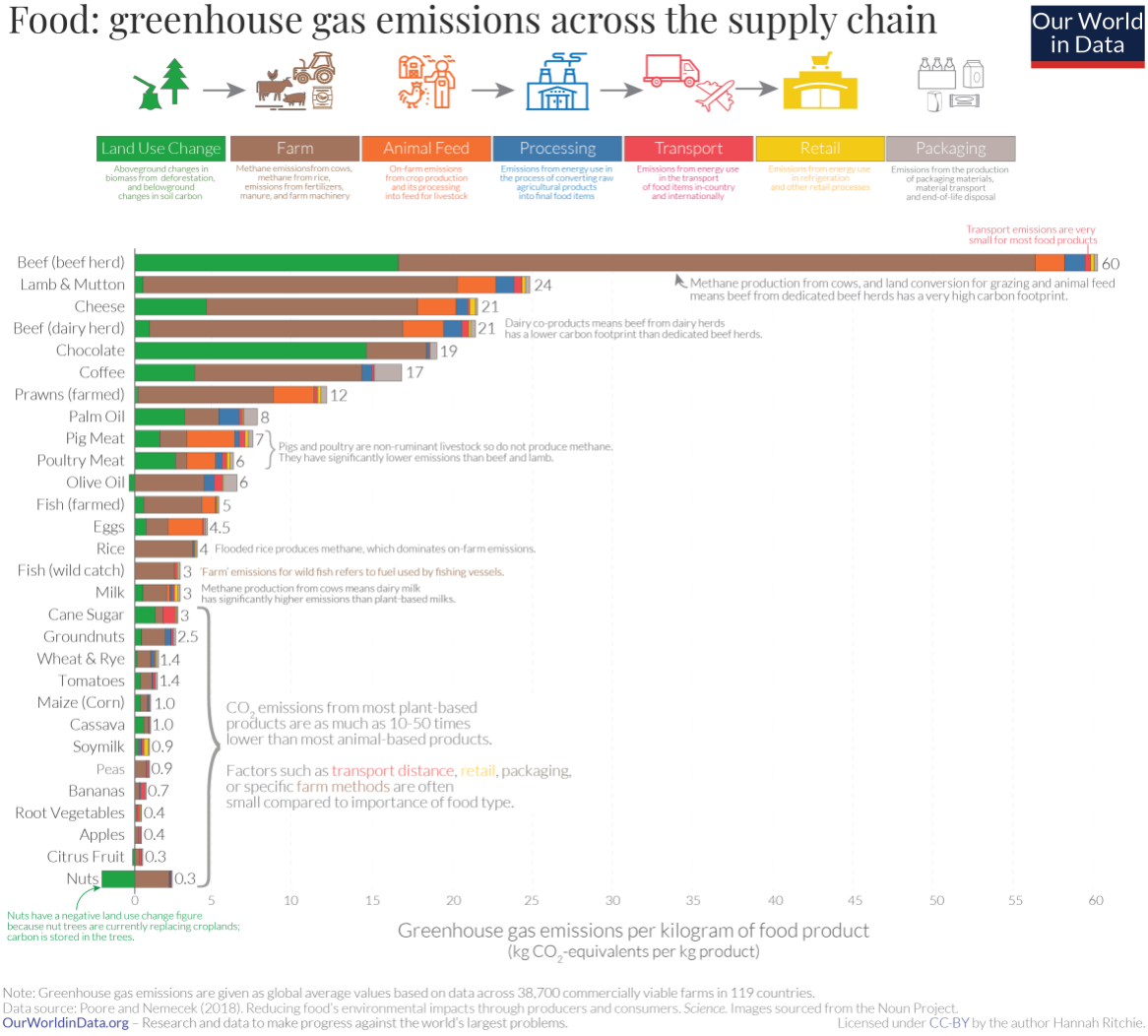
V. Appendices

Appendix 1: Sustainable Development Goals

(Source: (United Nations, n.d.)

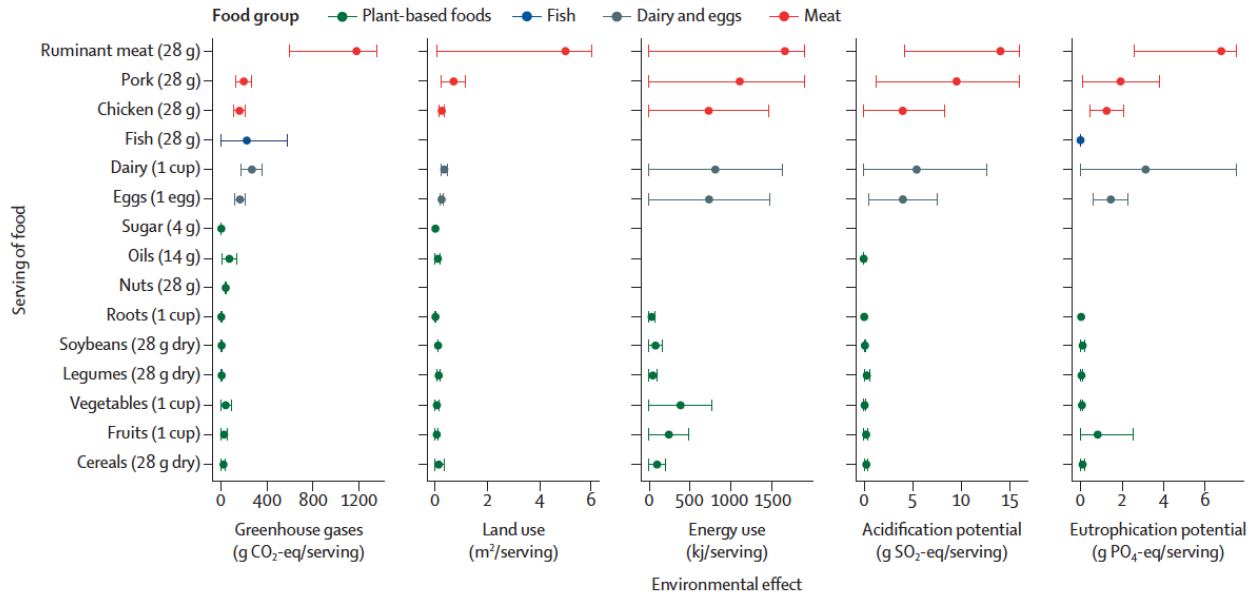
Appendix 2: GHGe of Food Products Along the Supply Chain

The overview of the value chain shows that farming is the largest source of GHGe, with beef (beef herd) standing out the most, followed by lamb and mutton, cheese, and beef (dairy herd). Especially the produced methane ("from cows and land conversion for grazing") shows a high level of pollution, which environmental impact is not discussed further due to limitations. Consequently, high values of GHGe are seen in land use change ("aboveground changes in biomass from deforestation and belowground changes in soil carbon"), with nuts showing a negative value as they bind CO_2. Apart from that, beef (beef herd) again has the highest value, followed by chocolate.



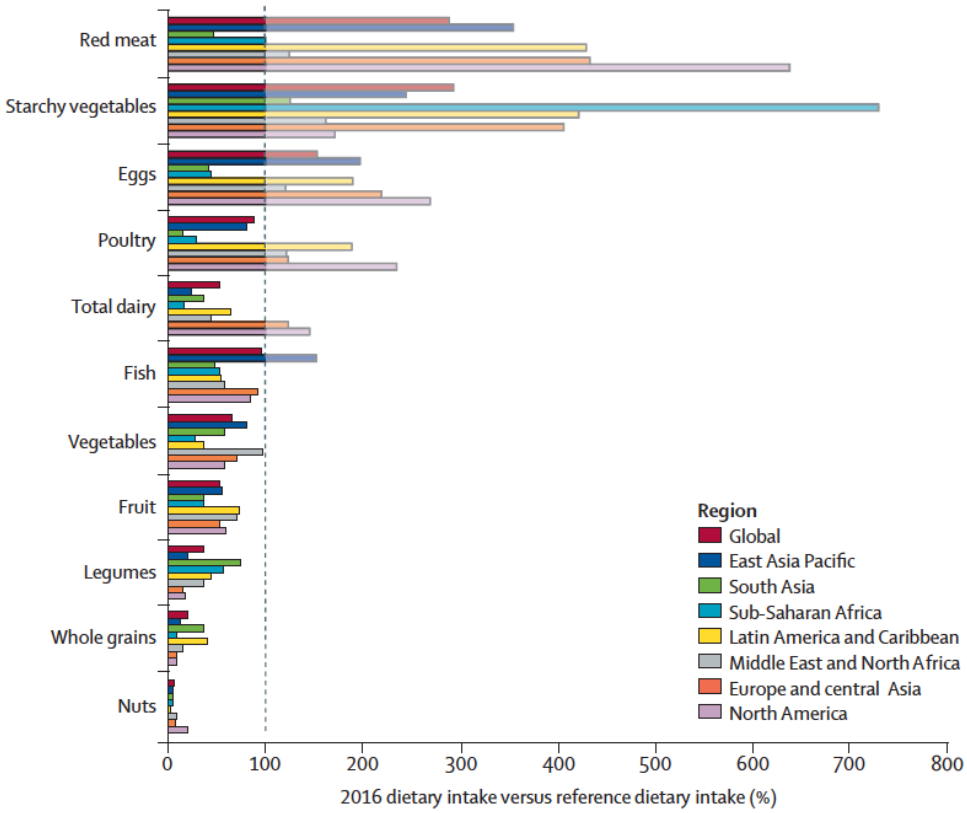
(Source: (Our World in Data, 2018)

Appendix 3: Environmental Effects Per Serving of Food Production



(Source: Willett et al., 2019, p. 471)

Appendix 4: "Diet Gap Between Dietary Patterns in 2016 and Reference Diet Intake of Food"



(Source: Willett et al., 2019, p. 460)

Appendix 5: Questionnaire

Hi!

Thank you for spending your time on my survey! This survey is key for accomplishing the final stage of my master's degree, my dissertation for my MSc in Management with a Specialization in Strategic Marketing at Católica Lisbon School of Business & Economics. It will take approximately 9 minutes to complete the survey. I kindly ask you to carefully read through the questions and answer them honestly. No right or wrong answers are possible. Of course, your answers will remain anonymous and confidential and the data will be used for my study only.

Again, thank you for your time and support!

Best, Sorin

Introduction to the experiment

This section is a simulating task, and we are interested about the value of the product for marketing purposes. Therefore, you will be shown several pictures of different food items followed by one question regarding each picture. Please, remember to respond honestly.

Example - Experimental Condition 3

Consider the food product: 1 Tomato (100g).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 1€.

0 0.2 0.4 0.6 0.8 1

0€

Consider the food product: Milk (1l).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 2€.

0 0.5 1 1.5 2

0€

Consider the food product: Butter (250g).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 4€.

0 1 2 3 4

0€

Consider the food product: Flour (1kg).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 3€.

0 1 2 3

0€

Consider the food product: Cheese (250g).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 4€.

0 1 2 3 4

0€

Consider the food product: 1 Apple (250g).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 1€.

0 0.2 0.4 0.6 0.8 1

0€

Consider the food product: Chicken (450g).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 6€.

0 1 2 3 4 5 6

0€

Consider the food product: Rice (500g).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 2€.

0 0.5 1 1.5 2

0€

Consider the food product: 6 Eggs.

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 4€.

0 1 2 3 4

0€

Consider the food product: Beef steak (250g).

Please, indicate how much (in €) would you be willing to pay for the shown product on the average price range from 0€ - 25€.

Beef steak

0 5 10 15 20 25

0€

Trust - Traffic Light Code Label

Is this label familiar to you?

- ◯ Yes
- ◯ No

Please, indicate from (1) "I do not trust this label at all." to (5) "I completely trust this label".

- ◯ 1 (I do not trust this label at all)
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 (I completely trust this label)

Trust - Carbon Footprint Label

Is this label familiar to you?

- ◯ Yes
- ◯ No

Please, indicate from (1) "I do not trust this label at all." to (5) "I completely trust this label".

- ◯ 1 (I do not trust this label at all)
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 (I completely trust this label)

Trust – Carbon Neutral Label

Is this label familiar to you?

- ◯ Yes
- ◯ No

Please, indicate from (1) "I do not trust this label at all." to (5) "I completely trust this label".

- ◯ 1 (I do not trust this label at all)
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 (I completely trust this label)

Social Identity

To what extent do you agree with the following statements on a scale from 1 (Strongly disagree) to 5 (Strongly agree)?

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
I am concerned about the development of the global environment.	○	○	○	○	○
I often buy eco-labeled products for the sake of the environment.	○	○	○	○	○
It concerns me that people do not care enough for the environment.	○	○	○	○	○
I feel it is a moral obligation to use environment-friendly products.	○	○	○	○	○

Carbon offsetting is the reduction of carbon dioxide or other greenhouse gas emissions, in order to compensate these e.g., through land restoration or the planting of trees.

To what extent do you agree with the following statements on a scale from 1 (Strongly disagree) to 5 (Strongly agree)?

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
Carbon offsetting should be mandatory.	○	○	○	○	○
Carbon offsetting will make no difference in the fight against climate change.	○	○	○	○	○
I trust companies offering carbon offsetting to use the money I paid in the right way.	○	○	○	○	○
Carbon offsetting is a way to quickly and easily tackle climate change.	○	○	○	○	○
Carbon offsetting is a waste of time.	○	○	○	○	○
Carbon offsetting encourages people to carry on doing things that harm the environment.	○	○	○	○	○
Carbon offsetting can help reduce unavoidable emissions.	○	○	○	○	○

Environmental Concern

To what extent to do you agree with the following statements on a scale from 1 (Strongly disagree) to 5 (Strongly agree)?

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
I would be embarrassed to be seen as having an environmentally friendly lifestyle.	○	○	○	○	○
I think of myself as an environmentally-friendly consumer.	○	○	○	○	○
I think of myself as someone who is very concerned with environmental issues.	○	○	○	○	○
I would not want my family or friends to think of me as someone who is concerned about environmental issue.	○	○	○	○	○

Demographics

How would you describe your diet?

- ○ Vegan (not consuming any animal products)
- ○ Vegetarian (not consuming any meat or fish)
- ○ Flexitarian (consuming red meat, poultry or fish no more than once a week)
- ○ Pescatarian (consuming no meat but fish)
- ○ Omnivore (eating meat or fish almost every day)
- ○ Prefer not to say

Please, select your gender

- ◯ Female
- ◯ Male
- ◯ Non-binary / third gender
- ◯ Prefer not to say

What is your age?

In which country do you currently reside?

What is your educational level?

- ◯ Less than High School
- ◯ High School graduate
- ◯ Bachelor
- ◯ Master/MBA
- ◯ Professional degree
- ◯ Doctorate
- ◯ Prefere not to say

What is your monthly net income?

- ◯ Less than 1000€
- ◯ 1000€ - 3000€
- ◯ 3001€ - 5000€
- ◯ 5001€ - 10,000€
- ◯ More than 10,000€
- ◯ Prefer not to say

Appendix 6: GHGe Resulting from Food Consumption in Germany

The first column shows the different food items and the second the per capita food consumption in Germany which is about 677 kg per year. The third column shows GHGe as CO_2e in kilograms and the last is about the direct GHGe resulting from consumption. These data are used to calculate the CO_2e per serving for the experiment, which is shown below.

food consumption	Per capita (in kg)	GHG emissions (in kg CO_2-equivalents per kg of food)	Direct GHG emissions resulting from per capita consumption (in kg CO_2-equivalents)
Cereal products			
Wheat flour	66.4	1.68	111.6
Rye flour	8.9	1.68	15.0
Other cereal products	16.4	1.68	27.6
Rice, beans and pulses, potatoes			
Rice	4.9	6.20	30.4
Beans and pulses	1.0	2.75	2.7
Potatoes	65.5	0.62	40.9
Potato starch	6.5	3.12	20.3
Sugar, honey and cocoa			
Sugar	33.9	2.81	95.2
Honey	1.0	–––	–––
Cocoa liquor	3.2	2.79	8.9
Fruit and vegetables			
Vegetables from horticulture*	92.7	0.90	83.4
Fruit from horticulture*	70.9	0.98	69.8
Citrus fruit	43.2	0.98	42.5
Nuts and nut-like seeds	4.1	1.77	7.3
Dried fruit	1.4	3.12	4.4
Meat and meat products, fish and fish products			
Beef and veal	12.6	20.65	260.2
Pigmeat	54.4	7.99	434.8
Sheepmeat and goatmeat	0.8	14.90	11.9
Poultrymeat	19.3	4.22	81.5
Other meat	2.2	11.94	26.3
Fish and fish products	15.7	4.12	64.6
Milk and dairy products			
Fresh milk products	84.6	1.76	149.2
Cream and cream products	5.7	3.28	18.7
Condensed milk products	2.7	3.28	8.8
Whole milk powder	1.3	14.70	19.1
Skimmed milk powder, powdered buttermilk	0.7	14.70	10.3
Cheese	22.8	7.84	178.7
Fats and oils, eggs and egg products			
Butter	6.0	14.77	88.6
Vegetable fats (margarine, vegetable oil)	15.1	2.48	37.5
Eggs and egg products	13.1	2.00	26.3
Totals	676.9	n.a.	1,976.3

(Source: (Noleppa, 2021, pp. 25–27)

Chicken Tikka Masala w/ Rice and Naan Bread

List of main ingredients by weight (more than 5g), excluding water.

		Quantity (g)				
Ingredient	%	TOTAL MEAL	MARINATED CHICKEN	SAUCE	RICE	NAAN BREAD
chicken	22%	**150**	150	-	-	-
rice	15%	**100**	-	-	100	-
tomato	11%	**77**	38	38	-	-
cream	8%	**50**	-	50	-	-
onion	7%	**46**	-	45	1	-
wheat flour	6%	**40**	-	-	-	40
yoghurt	5%	**33**	33	-	-	-
lemon	4%	**29**	-	29	-	-
rapeseed oil	3%	**22**	-	15	-	8
red bell pepper	2%	**13**	-	-	13	-
coriander	2%	**13**	3	10	0	-
spinach	1%	**10**	-	10	-	-
spice extracts	1%	**8**	2	5	1	-
palm oil	1%	**8**	8	-	-	-
salt	1%	**6**	1	1	3	1
rice flour	1%	**5**	-	-	5	-
corn flour	1%	**5**	5	-	-	-
corn starch	1%	**5**	-	5	-	-
Minor Ingredients	7%	**50**	10	19	10	12
CHICKEN TIKKA MASALA w/ RICE and BREAD TOTAL		**668**	**249**	**227**	**132**	**60**

		Footprint ($kgCO_2e$)				
Ingredient	%	TOTAL MEAL	MARINATED CHICKEN	SAUCE	RICE	NAAN BREAD
chicken	38%	**0.768**	0.768	-	-	-
cream	19%	**0.389**	-	0.389	-	-
rice	16%	**0.329**	-	-	0.329	-
rapeseed oil	3%	**0.065**	-	0.043	-	0.022
yoghurt	3%	**0.065**	0.065	-	-	-
wheat flour	3%	**0.057**	-	-	-	0.057
tomato	3%	**0.071**	0.036	0.036	-	-
butter	2%	**0.050**	-	0.050	-	-
palm oil	2%	**0.031**	0.031	-	-	-
rice flour	1%	**0.030**	-	-	0.030	-
lemon	1%	**0.027**	-	0.027	-	-
All other ingredients	8%	**0.162**	0.025	0.067	0.034	0.035
CHICKEN TIKKA MASALA w/ RICE and BREAD TOTAL		**2.04**	**0.93**	**0.61**	**0.39**	**0.11**

(Source: WWF, 2018, pp. 14–15)

Appendix 7: Calculation of CO_2e per Food Item

The calculations are based on the values given in Appendix 5. Based on the data of Noleppa (2021) and WWF (2018), calculations for the CO_2e-value per average serving for 10 food products are made.

Source: Noleppa (2021)	Food Item	Annual avergage consumption per capita (in kg)	Direct GHGe resulting from per capita consumption (in kg CO2 equivalent)	Direct GHGe resulting from per capita consumption per kg (in kg CO2 equivalent)	Avergae Packaging Serving in kg	Kg CO2e equivalent per food Item
1	Wheat flour	66,4	111,6	1,68	1	1,68
2	Eggs	13,1	26,2	2,00	0,21	0,42
3	Beef & Veal	12,6	260,2	20,65	0,25	5,16
4	Pigmeat	54,4	434,8	7,99	0,25	2,00
5	Fresh Milk	84,6	148,2	1,75	1	1,75
6	Cheese	22,8	178,7	7,84	0,25	1,96
7	Butter	6	88,6	14,77	0,25	3,69
8	Vegetables	92,7	83,4	0,90	0,25	0,22
9	Fruits (Apple)	70,9	69,8	0,98	0,25	0,25
10	Poultrymeat	19,3	81,5	4,22	0,25	1,06

Source: WWF (2018)		Serving size in kg	Kg CO2 equivalent	Kg CO2 / kg	Average Serving in kg	Kg CO2e equivalent per food Item
11	Tomato	0,038	0,036	0,95	0,25	0,24
12	Rice	-	-	6,20	0,5	3,10
13	Chicken	0,15	0,768	5,12	0,45	2,30
14	Oatly Milk	0,5	0,3	0,60	1	0,60
15	yoghurt	0,033	0,065	1,97	0,5	0,98

Appendix 8: Color Code for the Traffic Light Code Label

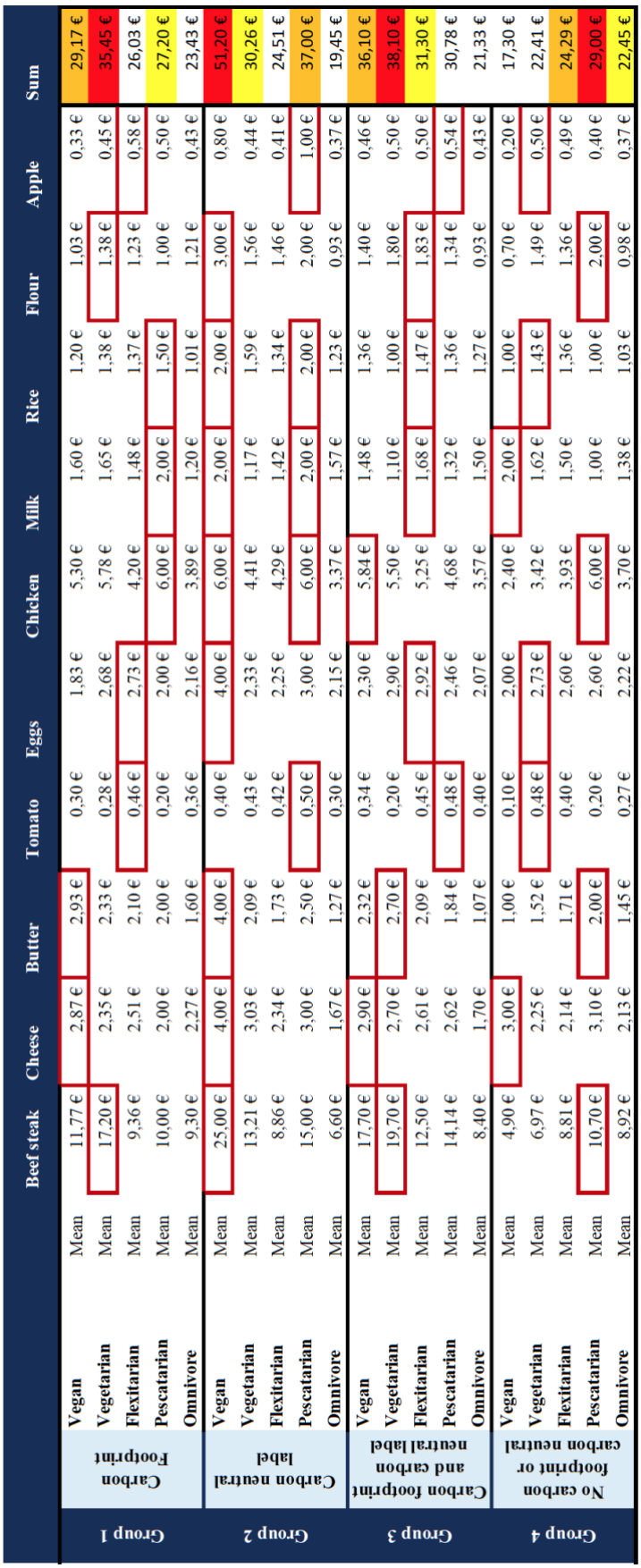
Color code	range (per KG)
A	0 to 3
B	3.01 to 6
C	6.01 to 9
D	9.01 to 12
E	>12

To determine the color code of the food items, the range of the highest and lowest (0 to 12) of the tested products were set as boundaries. Therefore, the range was divided by five, leading to five color code ranges.

Appendix 9: Average Market Price of Food Items

Source	Food product	Average serving in kg	Average price / serving	Upper bound
numbeo (2021)	Tomato	0,1	0,13 €	0,20 €
numbeo (2021)	Eggs	6	2,76 €	4,14 €
numbeo (2021)	Chicken	0,15	1,04 €	5,46 €
numbeo (2021)	Milk	1	0,88 €	1,32 €
GlobalProductPrices.com (n.d.)	Flour	1	1,58 €	2,37 €
GlobalProductPrices.com (n.d.)	Apple	0,25	0,50 €	0,75 €
MeinMetzger.de (n.d.)	Beef steak	0,25	17,00 €	25,50 €
SupermarktCheck.de (n.d.)	Rice	0,5	1,50 €	2,25 €
numbeo (2021)	Cheese	0,25	2.35 €	3.53 €
numbeo (2021)	Butter	0.25	2.10 €	3.15 €

Appendix 10: WTP per Diet behavior - means of WTP per experimental condition and per food item



			Beef steak	Cheese	Butter	Tomato	Eggs	Chicken	Milk	Rice	Flour	Apple	Sum
Group 1	Carbon Footprint	Vegan	Mean	11,77 €	2,87 €	2,93 €	0,30 €	1,83 €	5,30 €	1,60 €	1,20 €	1,03 €	0,33 €	29,17 €
		Vegetarian	Mean	17,20 €	2,35 €	2,33 €	0,28 €	2,68 €	5,78 €	1,65 €	1,38 €	1,38 €	0,45 €	35,45 €
		Flexitarian	Mean	9,36 €	2,51 €	2,10 €	0,46 €	2,73 €	4,20 €	1,48 €	1,37 €	1,23 €	0,58 €	26,03 €
		Pescatarian	Mean	10,00 €	2,00 €	2,00 €	0,20 €	2,00 €	6,00 €	2,00 €	1,50 €	1,00 €	0,50 €	27,20 €
		Omnivore	Mean	9,30 €	2,27 €	1,60 €	0,36 €	2,16 €	3,89 €	1,20 €	1,01 €	1,21 €	0,43 €	23,43 €
Group 2	Carbon neutral label	Vegan	Mean	25,00 €	4,00 €	4,00 €	0,40 €	4,00 €	6,00 €	2,00 €	2,00 €	3,00 €	0,80 €	51,20 €
		Vegetarian	Mean	13,21 €	3,03 €	2,09 €	0,43 €	2,33 €	4,41 €	1,17 €	1,59 €	1,56 €	0,44 €	30,26 €
		Flexitarian	Mean	8,86 €	2,34 €	1,73 €	0,42 €	2,25 €	4,29 €	1,42 €	1,34 €	1,46 €	0,41 €	24,51 €
		Pescatarian	Mean	15,00 €	3,00 €	2,50 €	0,50 €	3,00 €	6,00 €	2,00 €	2,00 €	2,00 €	1,00 €	37,00 €
		Omnivore	Mean	6,60 €	1,67 €	1,27 €	0,30 €	2,15 €	3,37 €	1,57 €	1,23 €	0,93 €	0,37 €	19,45 €
Group 3	Carbon footprint and carbon neutral label	Vegan	Mean	17,70 €	2,90 €	2,32 €	0,34 €	2,30 €	5,84 €	1,48 €	1,36 €	1,40 €	0,46 €	36,10 €
		Vegetarian	Mean	19,70 €	2,70 €	2,70 €	0,20 €	2,90 €	5,50 €	1,10 €	1,00 €	1,80 €	0,50 €	38,10 €
		Flexitarian	Mean	12,50 €	2,61 €	2,09 €	0,45 €	2,92 €	5,25 €	1,68 €	1,47 €	1,83 €	0,50 €	31,30 €
		Pescatarian	Mean	14,14 €	2,62 €	1,84 €	0,48 €	2,46 €	4,68 €	1,32 €	1,36 €	1,34 €	0,54 €	30,78 €
		Omnivore	Mean	8,40 €	1,70 €	1,07 €	0,40 €	2,07 €	3,57 €	1,50 €	1,27 €	0,93 €	0,43 €	21,33 €
Group 4	No carbon footprint or carbon neutral	Vegan	Mean	4,90 €	3,00 €	1,00 €	0,10 €	2,00 €	2,40 €	2,00 €	1,00 €	0,70 €	0,20 €	17,30 €
		Vegetarian	Mean	6,97 €	2,25 €	1,52 €	0,48 €	2,73 €	3,42 €	1,62 €	1,43 €	1,49 €	0,50 €	22,41 €
		Flexitarian	Mean	8,81 €	2,14 €	1,71 €	0,40 €	2,60 €	3,93 €	1,50 €	1,36 €	1,36 €	0,49 €	24,29 €
		Pescatarian	Mean	10,70 €	3,10 €	2,00 €	0,20 €	2,60 €	6,00 €	1,00 €	1,00 €	2,00 €	0,40 €	29,00 €
		Omnivore	Mean	8,92 €	2,13 €	1,45 €	0,27 €	2,22 €	3,70 €	1,38 €	1,03 €	0,98 €	0,37 €	22,45 €

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