Norwegian University of Life Sciences
School of Economics and Business

Philosophiae Doctor (PhD)
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Personality traits, food values and consumer behavior

Personlighetstrekk, matverdier og forbrukeratferd

Aida Tabarroky Ardebili

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To my mom, Marzieh

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Oslo, February 2021
Aida T. Ardebili

Contents

List of papers

The thesis contains the following papers:

Paper I: **Food values and personality traits: A comparative study between the United States and Norway**
Authors: Aida T. Ardebili and Kyrre Rickertsen
Working paper

Paper II: **Personality traits, knowledge, and consumer acceptance of genetically modified plant and animal products**
Authors: Aida T. Ardebili and Kyrre Rickertsen
Published in Food Quality and Preference

Paper III: **Food values, personality traits and attitudes towards genetically modified food**
Authors: Aida T. Ardebili and Kyrre Rickertsen
Working paper

Paper IV: **Sustainable food consumers: Dietary patterns, motives, and personality traits**
Authors: Aida T. Ardebili
Working paper

Summary

The thesis consists of four papers investigating the effects of personality traits and food values on food-related choices and behavior. The analysis uses data from the Norwegian Monitor Survey (NMS) and an online survey (OS) conducted in Norway and the US. Both data sets include a twenty-item version of the Big Five personality traits: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. The OS include a best-worst choice experiment with twelve food values: naturalness, safety, environmental impact, origin, fairness, nutrition, taste, appearance, convenience, price, animal welfare, and novelty. In the NMS, a simplified version of the method is used.

The first paper uses OS data and explores how personality traits influence respondents' preferences over the relative importance of food values in Norway and the US. A latent class logit model is estimated, which allows for heterogeneity by grouping individuals into different segments with homogenous preferences. Membership in each segment is specified to be a function of personality traits. In both countries, more open and agreeable respondents are more likely to belong to segments which emphasize the societal and environmental impacts of food.

The second paper uses NMS data to investigate the effects of personality traits and knowledge on the willingness to pay (WTP) to avoid genetically modified (GM) soybean oil, GM-fed salmon, and GM salmon. Each respondent stated WTP intervals for the three products. To take account of this panel structure a random-effects interval regression model is estimated. Conscientiousness and agreeableness are associated with attitudes towards GM food. Knowledge about bans against GM foods increases GM aversion.

The third paper uses OS data to investigate the effects of personality traits and food values on the WTP to avoid GM soybean oil, GM-fed salmon, and GM salmon. As in the second paper, a random-effects interval regression model is used. In both countries, high importance of price reduces GM aversion. Norwegian consumers are concerned about the safety of GM foods, while safety is not among the primary concerns of US consumers. Attitude towards GM food is associated with agreeableness and extraversion in the US, but no associations with personality traits is found in Norway.

The fourth paper uses NMS data to investigate respondents' dietary patterns from a sustainability perspective. Principal component analysis is used to identify dietary patterns from an extensive food frequency questionnaire. The roles of personality traits and food values on the adopted diets are explored using OLS regression. Three prevalent dietary patterns are identified. Open and agreeable respondents adopt more sustainable dietary patterns, which include more fruits, vegetables, and fish, and less meats. Environment, origin, and fairness are important motivations in adopting more sustainable diets while convenience and price are important barriers against adopting such diets.

The overall findings of the thesis can be summarized in four points: (1) Personality traits influence the preference structure for food values. Openness to experience and agreeableness are associated with more altruistic preferences. (2) The effects of personality traits on attitudes towards GM food are neither large nor consistent across products and samples. Food values are more important in determining the attitudes towards GM food. A large part of the resistance towards GM food seems to be based on perceptions that these products are less natural, less fair to stakeholders in the supply chain, more harmful to the environment, and bad for the welfare of animals. (3) Respondents' food consumption patterns reflect their differences in personalities and food values. More open and agreeable respondents adopt the dietary patterns that they perceive to have lower environmental impacts, fairer towards farmers, processors, and retailers, and protect local production. (4) Food values have larger and more consistent effects on food behavior than personality traits.

Sammendrag

Avhandlingen omhandler effekter av personlighetsfaktorer og matverdier på matrelatert atferd. Det blir brukt tverrsnittsdata fra Norsk Monitor (NM) i 2015 og fra en internettbasert spørreundersøkelse (IS) som ble gjennomført i 2015 i Norge og USA. En norsk versjon av Femfaktormodellen, som er basert på 20 spørsmål, blir brukt for å måle de fem personlighetsfaktorene åpenhet, planmessighet, ekstroversjon, omgjengelighet og nevrotisisme. De tolv matverdiene som måles er naturlighet, trygghet, miljøpåvirkning, opprinnelse, rettferdighet, ernæring, smak, utseende, enkelhet, pris, dyrevelferd og nyhet. IS kartlegger hvilke matverdier forbrukerne har ut fra «best-worst scaling»-metoden. NM bruker en forenklet utgave av metoden.

Den første artikkelen undersøker effektene av de fem personlighetsfaktorene på rangeringen av matverdier i Norge og USA ved hjelp av IS-data. En såkalt «latent class logit» modell blir estimert. Modellen åpner for heterogenitet ved å gruppere individer i forskjellige segmenter med homogene preferanser. Medlemskap i hvert segment er spesifisert som en funksjon av personlighetstrekkene. I begge land er det mer sannsynlig at åpnere og mer omgjengelige respondenter tilhører segmenter som vektlegger de samfunns- og miljømessige innvirkningene av mat.

Den andre artikkelen undersøker effektene av personlighetsfaktorene og kunnskap på betalingsvilligheten for å unngå genmodifisert soyaolje, laks som har blitt fôret med genmodifisert soya og genmodifisert laks ved hjelp av data fra NM. Betalingsvillighet for de tre produktene er registrert i intervaller, og denne panelstrukturen er tatt hensyn til gjennom estimeringen av en såkalt «random-effects interval regression» modell. Planmessighet og omgjengelighet er assosierte med holdninger til genmodifisert mat. Kunnskap om forbud mot genmodifisert mat øker aversjonen mot genmodifisering.

Den tredje artikkelen bruker IS-data. Artikkelen undersøker effektene av personlighetsfaktorene og matverdiene på betalingsvilligheten for å unngå genmodifisert soyaolje, laks som har blitt fôret med genmodifisert soya og genmodifisert laks. Som i den andre artikkelen blir en «random-effects interval regression» modell brukt. Vektlegging av pris er assosiert med lav aversjon mot genmodifisert mat i begge landene. Holdninger til

genmodifisert mat er assosiert med omgjengelighet og ekstroversjon i USA. Ingen tilsvarende assosiasjoner er funnet i Norge.

Den fjerde artikkelen benytter data fra NM for å undersøke respondentenes kostholdsmønstre i et bærekraftighetsperspektiv. Effekter av personlighetsfaktorene og matverdiene på kostholdsmønstre er undersøkt ved hjelp av en prinsipal komponentanalyse. Analysen er basert på matfrekvensdata i NM. Sammenhengene mellom personlighetsfaktorene og matverdiene er estimert ved minste kvadraters metode. Åpne og omgjengelige respondenter velger mer bærekraftige kostholdsmønstre med hyppigere forbruk av frukt, grønnsaker og fisk og mindre hyppig forbruk av kjøtt. Miljøpåvirkning, opprinnelse og rettferdighet er viktige matverdier for å velge mer bærekraftige kostholdsmønstre, mens enkelhet og pris er viktige barrierer mot dette.

Det er fire hovedfunn i avhandlingen. (1) Personlighetsfaktorene påvirker preferansestrukturen for matverdier. Åpenhet og omgjengelighet er assosiert med mer altruistiske preferanser. (2) Effektene av personlighetsfaktorene på holdningene til genmodifisert mat er verken store eller konsistente over produkter eller datasett. Matverdiene er viktigere for holdningene til genmodifisert mat. En stor del av motstanden mot genmodifisert mat er tilsynelatende basert på oppfatninger om at disse produktene er mindre naturlige, mindre rettferdige overfor deltakerne i matforsyningskjeden, farligere for miljøet og negative for dyrevelferden. (3) Kostholdsmønstre reflekterer forskjeller i personlighetsfaktorer og matverdier. Åpne og mer omgjengelige respondenter velger kostholdsmønstre som de tror har lavere miljøpåvirkning, er mer rettferdig overfor bønder, matindustri og dagligvarehandel og beskytter lokal matproduksjon. (4) Matverdiene har større og mer konsistente effekter på matrelatert atferd enn personlighetsfaktorene.

Introduction

The introduction consists of four main sections. In Section 1, I provide some motivation for the thesis and state the overall objectives. In Section 2, I provide a review of some relevant literature on food consumers' behavior. In Section 3, I provide a more detailed description of data sets, measurements, statistical methods, and a summary of each paper. In Section 4, the contributions, implications, and limitations of the thesis are discussed.

1. Motivation and Objectives

Food related behavior is complex. Numerous factors interact simultaneously and in multiple stages to influence the final choice of food. In this setting, a multidisciplinary analysis may improve the understanding of individuals' food-related behaviors. The thesis is mainly based in the economics of food consumption but it integrates psychological factors and motivation into analysis. This section consists of four subsections. First, I briefly describe some of the main approaches used to investigate food-related behaviors in economics. Second, I discuss the role of personality for food-related behaviors in economics. Third, I will discuss the role of food values for food-related behaviors in economics. Fourth, I state the overall objectives of the thesis.

1.1. The economics of food-related consumer behavior

The description is very brief and schematic and only intended to provide some background for the thesis. The section is to a large extent based on material found in Lusk, Roosen, and Shogren (2011).

Applied studies of consumers' behavior have typically been based on a consumer with (unobserved) stable preferences. The stable preferences are characterized by axioms of choice and are represented by a stable utility function. The consumer is assumed to maximize this utility function subject to a budget constraint. Utility is assumed to be a function of the consumed quantities of various goods. A stream of research has used this approach and associated developments in duality theory in the 1970s and 1980s on aggregate time series data. The initial focus was the effects of relative prices and real income

on consumer demand. Over time many other variables, such as information, advertising, and labeling have been included into this framework. More recently cross-sectional or panel household data have become available and used to this type of demand analysis.

Lancaster (1966) suggested another approach where utility does not come from the product itself, but rather the properties and characteristics of the product. Hedonic price theory (e.g., Rosen, 1974) is related to this model of utility. In hedonic pricing models, the price of a product is a function of its characteristics, and the implicit prices of these characteristics are estimated. Many studies have used hedonic price theory to estimate the implicit prices of various goods such as housing, PCs, cars, or food.

A third approach is based on Becker's (1976) household production theory. Becker's theory includes the opportunity cost of time, which is relevant for household consumption of food. For example, as the opportunity cost of time increases, the effort to prepare time-consuming homemade meals decreases and consumption of food away from home or easy meals increases.

A fourth approach is related to discrete choice modeling (DCM) (McFadden, 1974). In DCM, consumers' choices between a set of discrete alternatives are studied. It can be the choice to buy a food or not to buy it or the choice between different varieties of a food. Using DCM, the willingness to pay (WTP) for different types of food or product attributes have frequently been estimated. This also include the WTP for attributes that yet do not exist in the market. Such attributes could be related to genetically modified (GM) products, which also are used in this thesis. For attributes not available in the market stated preference methods have frequently been used. Stated preferences are based on questions that directly asks individuals to state their valuation of a product in a hypothetical setting.

A fifth approach is provided by behavioral economics. Behavioral economists and consumer researchers frequently criticized assumptions related to the basic utility theory and the axioms of choice that result in the existence of a stable utility function. These criticisms are based on human's predispositions to cognitive biases such as framing and anchoring effects, point of reference dependence (Tversky and Kahneman, 1974; 1981), preference reversals (Lichtenstein and Slovic, 1971), or attraction (decoy) effects (Huber, Payne, and Puto, 1982), just to name a few. Insights from this field of research suggest policy relevant solutions to prevent obesity and promote healthy eating through indirect strategies

such as size of packaging, menu design, manipulation of proximity or order of the food, and many more.

Parts of this thesis relates to the hedonic pricing approach and DCM. However, some variables have received less attention within applied economics and food-related behavior. The effects of personality and food values are of particular importance for this thesis.

1.2. Personality traits and the economics of food-related consumer behavior

The role of individuals' personality traits for food-related behaviors have been investigated in less detail. Personality may be defined as: 'relatively enduring patterns of thoughts, feelings, and behavior that reflect the tendency to respond in certain ways under certain circumstances' (Roberts, 2009: 140). The reason for neglecting personality traits may possibly be related to the 'person-situation' debate of Walter Mischel (1968), who suggested that behaviors are highly situation-specific. Although originally situationist proponents were on the winning side, research suggests that personality also matters. Evidence from neuroscience and behavioral genetics indicate that personality traits have biological basis, are heritable and a relatively stable determinant of behavior across several situations (Almlund et al., 2011).

Mischel himself, revised his idea (Mischel, 2004; 2009). In his later works, he acknowledged that although behavior might vary across situations, this variation is systematic. He referred to this variability as a stable "if…, then…" patterns which characterize individuals' personality. This stable variability of behavior across situations indicates that nonlinearities in relationship between situation and behavior exist (Almlund et al., 2011). In an extensive study, Borkenau et al. (2004) investigated the correlations between self- and observer-rated scores of personality traits and behavioral measures across 15 different tasks. They found that behavior is consistent both across the situations, and across "if … then …" patterns of situation and behavior interactions. They explained that behavioral styles and the way people act, such as talking with a loud voice, are expected to be more consistent across situations than frequency of a specific behavior, such as class attendance. As a result of this change in the way personality is viewed in the literature, several researchers have attempted to integrate personality measures in their analysis.

Borghans et al. (2008) explained that psychological constructs can be integrated in economic models through their influence on preferences and constraints. For example, sociability, empathy, and the ability to get along with others, which are facets of agreeableness and extraversion, can be a source of information or a learning environment. In a similar way, openness to experience fosters the willingness to learn and imaginations about future states, and the choice set of a shy person might be more limited while a warm and friendly smile is a resource for a salesperson (Borghans et al., 2008). For a review and discussion of integrating personality traits into economic models, see Borghans et al. (2008) and Almlund et al. (2011).

In the context of food-related behaviors, personality traits can influence preferences as well. Neuroticism and conscientiousness with facets such as immoderation, anxiety, and self-discipline can be a source of performing (avoiding) binge- or over-eating behaviors. In a similar way, excitement-seeking and the need for high levels of stimulation as facets of extraversion can be a source of preferences for hedonistic aspects of the food, while agreeableness with facets such as altruism and compliance can be a source of preferences for aspects of the food such as fair trade, animal welfare, and the like. Attempts to integrate personality traits in studying consumers' food-related behavior are increasingly growing and some of these studies are reviewed in Section 2 below.

1.3. Food values and the economics of food-related consumer behavior

The basic neoclassical consumer model assumes complete and stable preferences, which are known to the individual. As discussed above, this basic model has been modified in many directions. Of special interest for my thesis is Lusk and Briggeman (2009), who made the distinction between preferences and 'underlying preferences'.[1] They argued that it is not the preferences over food that are stable, but rather the desired outcome one wants to achieve from consuming the food. So, several preference reversals and inconsistencies in food choices can be due to a change in perceptions about the outcomes the product offers. For example, if the choice of organic food is due to the perception that organic food is more

[1] This distinction is not new and was also acknowledged by, for example, Becker (1976).

nutritious, the preference for organic food would be reversed once the consumer's perception about the nutritional value of organic food is changed, while the desire to consume nutritious food remains stable.

A value may be defined as "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence" (Rokeach, 1973:5). Lusk and Briggeman (2009) proposed a set of 'food values' and emphasized that these values are not referring to the abstract 'end-state of existence' as in Rokeach (1973). Rather they represent the underlying preferences over an intermediary value system that consumers develop in their food-related decision-making process (Lusk and Briggeman, 2009). These food values reflect consumers' food choice motivations and subjective beliefs about food products (Lusk, 2011a). This interpretation of food values corresponds well with the personal value negotiation system in the conceptual food choice model suggested by Furst et al. (1996).

1.4. Objectives of thesis

This thesis contributes to the body of literature in consumers' food-related behavior through integration of psychological factors and motivations. The main research questions are: (i) How are personality traits and food values interconnected? (ii) How do personality traits and food values influence consumers' attitudes towards food items produced by genetic engineering technologies? (iii) How do personality traits and food values influence dietary patterns? The specific objectives of each paper are discussed in Section 3.

2. Literature Review

The review will focus on a selection of the literature related to personality traits and food values. The volume of this literature has increased rapidly since I started working on my thesis. Literature related to WTP for genetically modified foods or sustainable food consumption are not discussed here.

A widely accepted taxonomy of personality traits is the Big Five model. It was developed through a lexical approach which is based on the idea that the distinguished

characteristics of individuals are manifested in their language (Almlund et al., 2011). The model has emerged as a result of independent works from several psychologists whose results indicated that personality traits can be categorized into five factors, each constituting lower-level facets (Almlund et al., 2011). These five factors are: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (OCEAN).

Several studies have found associations between personality traits and preferences for organic or local food (Gustavsen, and Hegnes, 2020a; 2020b), eating habits and consumption frequencies of different types of food (Keller and Siegrist, 2015), and alcoholic beverages (e.g., Gustavsen and Rickertsen, 2019). A review of the recent works on personality traits and food consumption finds that several of the detected associations have not been strong (Machado-Oliviera et al., 2020). Machado-Oliviera et al. (2020) clarify that different personality traits represent a predisposition to act in a certain way, however, such predispositions can be distracted by situations. Nevertheless, personality traits have also been found to be a relatively consistent determinant of food-related behaviors across situations.

Of particular interest for this thesis are the associations between OCEAN traits and dietary patterns and the associations between OCEAN traits and attitudes towards GM food. Several studies have investigated the associations between OCEAN traits and dietary patterns. Table 1 summarizes some of the results from the previous studies that have investigated the associations between individuals' dietary patterns as measured by food frequency questionnaire (FFQ), and the personality traits. The first column provides names of the author(s), the country of study, the sample size, the number of the items included in the FFQ, and the instrument used to measure the personality traits. The second column provides the dietary patterns either as detected by principal component analysis or grouped food items of the same category. The last five columns report the significant associations between each OCEAN trait and the dietary pattern or food group. The table suggests that across seven different studies conducted in six different countries, openness to experiences, conscientiousness and agreeableness are positively (negatively) associated with generally (un) healthier dietary patterns, while neuroticism is positively (negatively) associated with generally unhealthier (healthier) diets.

Table 1. A selection of the associations between OCEAN traits and dietary patterns

Study	Dietary pattern	O	C	E	A	N
Sutin & Terracciano (2016) US (N= 5,150) FFQ: 9 items Big Five, BFI-44	Healthy	Pos.	Pos.	Pos.	Pos.	Neg.
	Convenience		Neg.		Neg.	Pos.
Mõttus et al. (2012) Estonia (N=1,691) FFQ = 15 items Big Five, NEO PI-3, 240 items	Health aware	Pos.	Pos.	Pos.		Neg.
	Traditional	Neg.				
Mõttus et al. (2013) Scotland (N = 1,091), Cohort study FFQ= 168 items NEO FFI, 60 items	Mediterranean	Pos.		Pos.		Neg.
	Health aware		Pos.		Pos.	
	Convenience	Neg.				Pos.
	Sweet foods	Neg.				
Pfeiler & Egloff (2020) Australia (N = 13,892) FFQ = 14 items Big Five PI, 28 items	Plant-based and fish	Pos.	Pos.			Neg.
	Meat	Neg.		Pos.		Pos.
	Carbohydrate-based		Neg.	Neg.		Pos.
Weston, Edmonds & Hill (2020) US (N = 665), Cohort study FFQ = 24 items Big Five, NEO IPIP, 120 items	Healthy	Pos.	Pos.		Pos.	Neg.
	Unhealthy	Neg.	Neg.		Neg.	Pos.
Keller & Siegrist (2015) Switzerland (N = 951) FFQ = 12 items Big Five, NEO-FFI 60 items	Fruits and vegetables	Pos.				
	Meat	Neg.		Pos.	Neg.	
	Sweetened drink	Neg.		Pos.		
Tiainen et al. (2013) Finland (N= 1681), Cohort study FFQ = 128 items (Reduced to 12 groups) Big Five, NEO-PI, 181 items	Fruits	Pos.	Pos.			
	Vegetables	Pos.	Pos.	Pos.		Neg.
	Meat	Neg.		Pos.	Neg.	

Very few studies have investigated the role of OCEAN traits in determining attitudes towards GM food or labeling of the GM food, and Table 2 summarizes the results from these studies.[2] The first column provides the name(s) of the author(s), the elicitation method and measurement of the attitudes, the product included in the study, and the instrument used to measure the personality traits. The second column reports the sample origin and size, and the last five columns report the significant associations between each trait and attitudes towards GM food. As indicated by the table, several associations have not been consistently

[2] Research on this topic is growing rapidly. There may be other studies that are unintentionally overlooked.

replicated across the samples or products, and contradictory results were also found. For example, extraversion and agreeableness were respectively associated with positive and negative attitudes towards GM food in Lin et al. (2019), while these traits were found to have opposite associations with perceptions about safety of GM food in Whittingham, Boecker & Grygorczyk (2020).

Table 2. Associations between OCEAN traits and attitudes towards GM food/labeling

Study	Sample	O	C	E	A	N
Lin et al. (2019) Hypothetical choice experiment WTP for GM pork Big Six, MIDI 30 items	US (N = 945) China (N = 945) Italy (N = 954)	Accept Accept Accept	Averse Averse	Accept	Averse	
Whittingham, Boecker & Grygorczyk (2020) Data from Twitter GM food Risk perception Big Five, lexical analysis	Canada (N= 522)	Safe		Unsafe	Safe	Safe
DeLong & Grebitus (2018) Survey GM labeling, sugar Big Six, MIDI 30 items	US (N = 566)		Label			
Peschel et al. (2019) Online choice experiment Production method (GM-free) labeling, Medjool date Big Six, MIDI 30 items	US (N = 1,411)	Label				Label

The role of values and beliefs are well established in consumer and marketing research through models such as expectancy-value theory (Fishbein and Ajzen, 1975), means-end chain model (Gutman, 1982), and the theory of planned behavior (Ajzen, 1985). According to the expectancy-value theory, people develop attitudes from their beliefs about a product. Means-end chain model is based on the assumption that consumer's behavior in the marketplace is influenced by the product attributes that can potentially satisfy the values important to the individual. Theory of planned behavior makes distinctions between three types of beliefs: behavioral beliefs which determine the attitudes, normative beliefs which determine the subjective norms, and control beliefs which determine the perceived

behavioral control. Attitudes, subjective norms, and perceived behavioral control jointly determine intentions to perform a certain behavior.

Several studies have used theory of planned behavior, expectancy-value theory, and means-end chain models to study the influence of values and beliefs on attitudes towards different food items. For example, Nystrand and Olsen (2020) found that attitudes towards consumption frequency of functional food is associated with utilitarian eating values, i.e., health issues, control weight and avoidance of weight increase issues; Olsen et al. (2011) found that importance of benevolence value is associated with emphasizing the environmental and health consequences, and importance of hedonic value is associated with emphasizing the taste quality in choice of novel processed apple juice; and Olsen et al. (2007) found that orientation towards convenience of the food is positively associated with perceived inconvenience of fish, and perceived inconvenience of fish forms negative attitudes towards fish and fish consumption.

Lusk and Briggeman (2009) conducted a review of the literature on consumers' attitudes towards food products and studies which employed means-end chain analysis to identify a set of relatively stable food-related values. They suggested eleven food values: safety, nutrition, naturalness, environmental impact, taste, appearance, convenience, tradition, origin, fairness, and price. Lusk and Briggeman (2009) explained that several of these values correspond with Schwartz' (1992) value dimensions.[3] Studying the role of food values can give an overall understanding about consumers' general belief and attitudes towards a food product or consumption behavior.

Food values were proposed as a useful construct about a decade ago, and studies have investigated the relative importance of food values across countries (e.g., Bazzani et al., 2018) and products (Lister et al., 2017). The associations between food values and preferences for specific food products such as organic or functional food have also been investigated (Lusk, 2011a; Pappalardo and Lusk, 2016). However, several interesting associations have not been studied including associations between food values and attitudes towards GM food, associations between food values and individuals' general dietary

[3] Schwartz (1992) suggested a set of ten basic value dimensions that drive individuals' latent motivations and goals: achievement, benevolence, conformity, hedonism, power, security, self-direction, stimulation, tradition, and universalism.

patterns, and associations between food values and personality traits. These associations are in focus of this thesis.

3. Data and Methods

Table 3 summarizes the main research objectives, the key variables, the data sets, the statistical models, and the key findings of each paper. In this section, I will describe the two data sets used, measurement of the personality traits and food values, the statistical models applied in each paper, and the research objectives and key findings of each paper.

3.1. Data sets

Two sets of data were used: data obtained from an online survey (OS) conducted in Norway and the US and Norwegian Monitor Survey (NMS).

The OS was conducted between October and November in 2015 in Norway and the US; 1,037 participated in Norway and 1,025 participated in the US. The survey included data on respondents' stated preferences for three types of GM foods, organic food, attitudes, personality traits, and a choice experiment based on best-worst scaling (BWS) method to elicit the relative importance of the food values. The papers (I) and (III) used data from this survey.

NMS is a nationally representative survey that has been conducted every second year in Norway since 1985, with approximately 3,000 to 4,000 respondents in each round. This survey is one of the most comprehensive consumer surveys in Norway and includes more than three hundred questions about consumers' beliefs and attitudes towards several individual, political, and social issues, as well as questions about their general physical and mental health status, lifestyle, eating habits, consumption frequency of food items, and much more. Only the 2015 survey included questions related to personality traits and food values and only data from this survey was used.[4] The papers (II) and (IV) used NMS data.

[4] The NMS was also conducted in 2017 and 2019, however, we did not have access to these more recent data.

Table 3. Main objectives, key variables, data sources, statistical models, and key findings of the thesis

Paper	Main objectives	Key variables	Data	Statistical model	Key findings
I	○The role of the Big Five traits in preferences for food values	BFI-20 (avg. scores) Food values (BWS)	OS	▪ LCL	✓ Openness and agreeableness are positively associated with higher importance of societal values of the food in both countries ✓ Extraversion is negatively associated with importance of societal values of food in Norway
II	○The role of the Big Five traits and knowledge on WTP to avoid GM foods ○The role of the Big Five traits on knowledge about GM-food restrictions	Stated WTP BFI-20 (CFA and age-adjusted) Knowledge Naturalness	NMS	▪ Probit ▪ CFA ▪ Interval regression	✓ Conscientiousness is associated with GM acceptance and less knowledge about GM regulations ✓ Agreeableness is associated with GM aversion and better knowledge about GM regulations ✓ Knowledge about the bans against GM foods is associated with GM aversion
III	○The effects of the Big Five traits and food values on consumers' WTP to avoid GM foods	Stated WTP BFI-20 (avg. scores) Food values (BWS)	OS	▪ Interval regression	✓ Higher importance of naturalness, environment, fairness, appearance, animal welfare, origin, and convenience increase GM aversion in both countries ✓ Higher importance of safety increases GM aversion in Norway ✓ No personality effects in Norway ✓ Extraversion is associated with GM aversion and agreeableness is associated with GM acceptance in the US
IV	○Identify dietary patterns among Norwegians and evaluate them with sustainability focus ○The role of the Big Five traits and food values on adopting a sustainable dietary pattern	FFQ BFI-20 (avg. scores) Food values (simple BWS)	NMS	▪ PCA ▪ OLS	✓ Three diets are identified: sustainable, traditional, and unsustainable ✓ The sustainable and traditional diets correspond with several sustainability recommendations in the Norwegian context ✓ Openness is associated with the sustainable diet, agreeableness is associated with the traditional diet, and extraversion is associated with the unsustainable diet ✓ Higher importance of environmental impact, fairness, and origin are associated with adopting relatively more sustainable diets ✓ Convenience and price are most important barriers against consumption of fruits and vegetables and an important motivation to adopt unsustainable diet

3.2. Personality traits

Measurement of the personality traits were identical in both data sets. The Big Five Inventory (BFI) is one of the most widely used personality tests to measure the Big Five personality traits. This model is developed by John, Donahue, and Kentle (1991) and their version was based on 44 items (BFI-44). Engvik and Føllestad (2005) translated BFI-44 to Norwegian and showed its acceptable psychometric properties. Thereafter, Engvik and Clausen (2011) validated a 20-item version of this model, and proved the acceptable psychometric properties of this version (BFI-20). BFI-20 was used in NMS and the OS. Items were measured by self-reported scores on a scale from 1 (the item does not describe the respondent at all) to 7 (the item describes the respondent very well). Table 4 presents the Big Five traits, their definition according to American Psychological Association (APA, 2007), and the measurements of each trait. BFI-20 in English was used in the OS conducted in the US, and in Norwegian in the NMS and the OS conducted in Norway.

In the thesis, respondents' scores of the five personality traits were calculated using two different methods. Paper (II) was written first. In this paper, the scores were calculated following a two-step procedure. In the first step, a confirmatory factor analysis (CFA) using maximum likelihood estimation method was conducted. CFA is a multivariate technique used to test the extent to which the measured variables represent the constructs well (Hair et al., 2014: 603), and the mathematical specification of this model is explained below. Scores of the personality traits were predicted for each trait and each respondent from the estimated CFA. It has been debated to what extent personality traits can change with age across the life course (e.g., Almlund et al., 2011). Therefore, following some previous studies (e.g., Bucciol and Zarri, 2017), the personality scores were adjusted for age effects in the second step. In particular, the personality scores were regressed on age and its second-degree polynomial, and the resulting standardized residuals were used as the respondents' scores on the five traits.

When the next paper was submitted for review an anonymous reviewer recommended the use of average scores rather than the method used in the previous paper. The reviewer had three main arguments. First, factor scores are specific to the sample since they reflect the covariance structure of the sample and therefore lack generalizability.

Table 4. Big Five Inventory based on 20 items

Trait: APA definition [a]	Measurement [b]
	I see myself as someone who…
Openness to experience: The tendency to be open to new aesthetic, cultural, or intellectual experiences	• Is original, comes up with new ideas • Has lively imaginations • Likes to reflect, play with ideas • Has few artistic interests
Conscientiousness: The tendency to be organized, responsible, and hardworking	• Does a thorough job • Tends to be disorganized • Makes plans and follows them through • Can be somewhat careless
Extraversion: An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience	• Is talkative • Tends to be quiet • Is outgoing, sociable • Is sometimes shy, inhibited
Agreeableness: The tendency to act in a cooperative, unselfish manner	• Can be cold and aloof • Is helpful and unselfish with others • Is sometimes rude to others • Is considerate and kind to almost everyone
Neuroticism: A chronic level of emotional instability and proneness to psychological distress	• Is depressed, blue • Is relaxed, handles stress well • Worries a lot • Gets nervous easily

Source: The table is adopted from Almlund et al. (2011), and adjusted to measurements used in BFI-20.
Notes: [a] Definitions according to American Psychology Association (APA, 2007). [b] Measurement of the five traits in BFI-20 developed by Engvik and Clausen (2011). Response alternatives were scores on a scale from 1 (the item does not describe the respondent at all) to 7 (the item describes the respondent very well).

Second, a main purpose of CFA is to examine the psychometric properties of the constructs, which is not the objective of our study. Third, for sake of simplicity. We followed the reviewer's advice in the three other papers.[5] For each respondent and each trait, the average scores of the items associated with the trait was calculated and standardized, and these

[5] Prior to receiving this advice, we considered CFA with weighted least square mean and variance adjusted estimator (WLSMV). The reason was that CFA with ML estimation had some limitations. ML estimator assumes that data is continuous with a multivariate normal distribution. Finney and DiStefano (2013) found that the consequences of employing ML with categorical and/or non-normal data was minor and could be neglected when the number of categories is high (≥ 5) and/or non-normality is less severe (skewness < 2 and kurtosis < 7). However, WLSMV estimator takes the ordinal nature of the response items into account and is robust to potential non-normality, and therefore, is a better choice for estimation of CFA with our data than ML.

standardized scores were used as the respondent's scores on the traits. The results were somewhat sensitive to the choice of method, but the main results and general conclusions of each paper did not change substantially.

3.3. Food values

A slightly revised version of the food values introduced in Lusk and Briggeman (2009) was suggested by Bazzani et al. (2018). The food values suggested by Bazzani et al. (2018) are: taste, price, nutrition, naturalness, environmental impacts, animal welfare, fairness, origin, convenience, novelty, appearance, and safety. This version was used in NMS and the OS. Table 5 presents the list of food values and their definition suggested by Lusk and Briggeman (2009) in the first column, and the list of food values and their definition suggested by Bazzani et al. (2018) in the second column. The most important differences between the two lists are the omission of tradition as a food value and the addition of animal welfare and novelty as food values. According to Bazzani et al. (2018), research suggested that variety seeking and animal welfare are playing an important role in consumers' food choices. Moreover, the authors excluded tradition defined as 'preserving traditional consumption patterns' because it could be interpreted differently across individuals with diverse ethnic background.

Lusk and Briggeman (2009) suggested to elicit the relative importance of these food values using the best-worst scaling (BWS) method, which originally was developed by Finn and Louviere (1992). In the BWS method, repeated choice scenarios are presented to the respondents and they are asked to indicate the most and least important food values in each scenario. BWS is likely to overcome some potential disadvantages related to other measurement methods such as rankings and Likert scales. The BWS method forces the respondents to discriminate between what is most and least important and they cannot rank all values as most or least important. Moreover, to rank something as either the most or least important has the same interpretation for all respondents, which mitigate problems arising from measurement units and subjective interpretation of rankings or Likert scales (Flynn and Marley, 2014).

Table 5. Food values and description

Lusk and Briggeman (2009) [a]	Bazzani et al. (2018) [b]
Naturalness (extent to which food is produced without modern technologies)	Naturalness (made without modern technologies like genetic engineering, hormone treatment and food irradiation)
Safety (extent to which consumption of food will not cause illness)	Safety (eating the food will not make you sick)
Environmental impact (effect of food production on the environment)	Environmental impact (effect of food production on the environment)
Origin (where the agricultural commodities were grown)	Origin (whether the food is produced locally, in USA/Norway or abroad)
Fairness (the extent to which all parties involved in the production of the food equally benefit)	Fairness (farmers, processors and retailers get a fair share of the price)
Nutrition (amount and type of fat, protein, vitamins, etc.)	Nutrition (amount and type of fat, protein, etc.)
Taste (extent to which consumption of the food is appealing to the senses)	Taste (the flavor of the food in your mouth)
Appearance (extent to which food looks appealing)	Appearance (the food looks appealing and appetizing)
Convenience (ease with which food is cooked and/or consumed)	Convenience (how easy and fast the food is to cook and eat)
Price (the price that is paid for the food)	Price (price you pay for the food)
Tradition (preserving traditional consumption patterns)	
	Animal welfare (well-being of farm animals)
	Novelty (the food is something new that you have not tried before)

Source: This is Table 2 in Bazzani et al. (2018)
Notes: [a] List of the food values and descriptions suggested by Lusk and Briggeman (2009). [b] A revised version of the Lusk and Briggeman's food values, suggested by Bazzani et al. (2018). This revised version is used in the current work.

The relative importance of the food values was elicited differently in each data set. A choice experiment with nearly balanced incomplete block design (NBIBD) and the BWS method was used in the OS as the elicitation method. Respondents were asked to indicate the most and least important food values from 12 choice sets where each choice set consisted of a subset of 4 food values. Definition of the food value was provided under each food value in the choice set. Figure 1 illustrates an example of a choice set. Each food value was repeated 4 times across the 12 choice sets, and was paired with other food values 1.09 number of times. This design maximized the D-efficiency score; 98.71%.

Figure 1. Example of a choice set

Which of the following attributes is most important and which is least important when you purchase food? Please, check only one attribute as the most important and only one attribute as the least important.

Most Important ONE ANSWER	Attribute	Least Important ONE ANSWER
□	Appearance (the food looks appealing and appetizing)	□
□	Novelty (the food is something new that you have not tried before)	□
□	Fairness (farmers, processors and retailers get a fair share of the price)	□
□	Origin (whether the food is produced locally, in the US or abroad)	□

Source: This is Figure 1 in Bazzani et al. (2018).

In paper (I), OS is used and data obtained from the BWS choice experiment was analyzed using a latent class logit model, which is explained below. Paper (III) also uses the OS data. In this paper the preferences over relative importance of the food values were used as a set of explanatory variables, and the counting method was employed to calculate 'importance score' of each food value for each respondent. In particular, for each respondent, the number of the times each food value was chosen as the most important and the least important food value was counted. The number of times each food value was chosen as least important was then subtracted from the number of times it was chosen as most important.[6] Given that each food value appeared four times across the choice sets, the range of the importance scores were from -4 to 4, and they summed to zero across all food values.

Paper (IV) uses NMS data. The NMS is based on a large questionnaire with more than three hundred questions, and therefore, a short version of BWS method was employed. In NMS, all the food values were presented in one table, and respondents were asked to choose the least and the most important values from the table. As a result, the elicited preferences

[6] These scores are referred to as the 'importance scores' (Lusk and Briggeman, 2009) or 'best-worst scores' (Pappalardo and Lusk, 2016).

only indicate the most and least important food values for each respondent. It is impossible to infer any additional information about the relative importance of the other 10 values. These food values were effect coded. In particular, the food value was set to 1 if it was chosen as the most important, was set to -1 if it was chosen as the least important, and was set to 0 if it was not chosen by the respondent. The effect coded food values were used as a set of explanatory variables in paper (IV).

3.4. Statistical models

Several statistical models were used in the thesis. A latent class logit (LCL) model was used in Paper I. In Paper II, a random-effects interval regression and a probit model were used along with a confirmatory factor analysis (CFA). A random-effects interval regression model was used in Paper III, while principal component analysis (PCA) and ordinary least squares (OLS) were used in Paper IV. Except for OLS and PCA, the statistical models in the thesis can be described within a latent variable framework. A latent variable is a variable that is not directly observed but measured through other observable variables. I will briefly describe the models used in my thesis. In this description, I will also briefly describe some models that are closely related to the models used.

3.4.1. The probit model

In my presentation, I mainly follow Wooldridge (2010) in model specifications. Look at the simple case where the outcome is a binary variable that only can take two values. A typical example could be to purchase or not purchase a food. Let the binary variable y_i represent the observed value for the continuous latent variable y_i^* for observation i, such that:

$$y_i^* = x_i\beta + e_i\ ,\ y_i = I[y_i^* > 0] \quad (1)$$

where x_i is the vector of explanatory variables, β is the associated parameters, e_i represents an unobserved error term that is assumed to be uncorrelated with x_i, and $I[.]$ is an indicator function.[7] Usually the probability of the outcome given the set of explanatory variables $P(y_i = 1\,|x)$ is of particular interest. The most basic model would be the linear probability

[7] An indicator function $I[.]$ equals to 1 when the argument is true and zero otherwise.

model where the probability is a linear function of the explanatory variables. The model has two obvious shortcomings. First, it is subject to heteroscedasticity by construction. Second, when the interest is the predicted probability, the model may produce probabilities beyond the acceptable range of [0,1].

Alternatively, one can let $x\beta$ depend on the observed y through a function that limits the range of predicted outcome such that $P(y_i = 1\,|x_i) = G(x_i\beta)$. Given a standard normal distribution $\Phi(x_i\beta)$, we have the probit model and given a logistic distribution $\Lambda(x_i\beta)$ we have the logit model.

3.4.2. The random effects interval regression model

Sometimes we are interested in modelling an outcome variable that can take more than two values, where the values assigned to the outcome are not arbitrary. Assume for an underlying outcome variable y^* we observe ordered values $y_1 < \cdots < y_J$, where higher values indicate higher levels of y^*. There are two possibilities: (i) the cutoff points are not known and must be estimated and (ii) the cutoff points are known.[8] In the latter case, the underlying latent variable y^* has a quantitative meaning, such as income level or stated willingness to pay, but due to reasons such as the survey design, data is recorded in pre-specified intervals. Assuming a normal distribution for the underlying outcome variable y^* results in an interval regression model, which is a generalization of the Tobit model with known intervals (Amemiya, 1973). The conditional response probability for each interval is then:

$$P(y_i = 1|x_i) = P(y_i^* \le y_{i1}|x_i) = \Phi(\tfrac{y_{i1} - x_i\beta}{\sigma})$$

$$P(y_i = 2|x_i) = P(y_{i1} < y_i^* \le y_{i2}|x_i) = \Phi\left(\tfrac{y_{i2} - x_i\beta}{\sigma}\right) - \Phi(\tfrac{y_{i1} - x_i\beta}{\sigma})$$

$$\vdots$$

$$P(y_i = J|x_i) = P\left(y_{iJ} < y_i^*|x\right) = 1 - \Phi(\tfrac{y_{iJ} - x_i\beta}{\sigma}) \qquad (2)$$

where Φ is the standard normal cumulative distribution function, and σ is the standard error of the underlying outcome variable. The parameters of interest can be obtained by maximizing the sample likelihood function, with probabilities specified in Equation (2).

[8] In this first case, assuming a standard normal distribution or logistic distribution for the latent variable results in the ordered probit or ordered logit model, respectively.

By specifying a respondent specific random-effects component for the underlying outcome variable, the interval-regression model can be extended to random-effects interval regression to account for the panel structure in the data. In particular, $y_{it}^{*} = x_{it}\beta + v_i + e_{it}$, where $v_i \sim N(0, \sigma_v^2)$ represents the respondent-specific random variation that is assumed to be iid, and $e_{it} \sim N(0, \sigma_e^2)$ represents all other unobserved factors and is assumed to be independent of v_i. The contribution of the panel-level variance to total variance can be computed as $\rho = \frac{\sigma_v^2}{\sigma_e^2 + \sigma_v^2}$.

3.4.3. Principal component analysis

PCA is a multivariate technique widely used for data reduction purposes. This could be situations where one is dealing with a set of highly correlated variables, such as food frequency questionnaires, where the objective is to reduce the large number of observed variables to a smaller subset of principal components. The methodology in PCA is to generate the set of linear combinations of random variables that have the maximum variance. I follow Jöreskog, Olsson, and Wallentin (2016) in specification of the PCA model. Let $x = (x_1, \dots, x_p)'$ be a vector of p observed random variables, and $c = (c_1, \dots, c_p)'$ a vector of uncorrelated components constructed from linear combinations of p variables in x such that:

$$c = A'x \tag{3}$$

where A is a $p \times p$ matrix representation of linear transformation of xs, in which column j is the vector of linear transformation generating c_j. PCA's objective is to maximize the variance of the normed linear combinations:[9]

$$\text{Maximize} \quad \text{var}(c) = A'\Sigma A \quad \text{Subject to} \quad A'A = I \tag{4}$$

where Σ denotes the covariance matrix of x. The maximization problem is solved by maximizing the Lagrangian function $\mathcal{L} = A'\Sigma A - \Gamma(A'A - I)$, where Γ is a diagonal matrix of p Lagrangian multipliers; γ. The first-order conditions (FOCs) in the maximization problem can be presented as (i) $\Sigma A = \Gamma A$ and (ii) $A'A = I$. The condition (i) implies that γs are the eigenvalues of Σ with associated eigenvectors represented in columns of A. Moreover, using

[9] Normed linear combination of p random variables; $a_1 x_1 + \cdots + a_p x_p$, is defined such that $a_1^2 + \cdots + a_p^2 = 1$.

(ii) and some matrix manipulation one can show that $A'\Sigma A = \Gamma$, which implies that the eigenvalues; γs, are in fact the variances to be maximized.

From p random variables, one can extract p uncorrelated components, such that the first component account for the most variance, the second component accounts for the second most variance, and so on until all the variance in the data is accounted for. In practice, one hardly ever retains all the principal components. Rather the first k components that have largest eigenvalues are retained to capture the essence of most important variability in the data, and the $p - k$ remaining components are ignored. The k principal components summarize the original set of observed variables in groups where a subset of variables vary together. Once k principal components are retained, scores for these principal components can be predicted, and be used for subsequent analyses.

3.4.4. Confirmatory factor analysis

There are two types of factor analysis (FA): exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). EFA is an exploratory data-driven technique to explore the number of underlying factors that can best represent the data, while CFA uses a priori specification of the number of factors, and a priori pattern of the associations among factors and observed variables to test whether the specified patterns of associations represent the actual data (Hair et al., 2014:603).

PCA and FA have some apparent similarities, but they are different both in terms of theoretical assumption and mathematical specifications. While FA assumes existence of underlying latent factors, PCA does not make such assumption. The exiting latent factors in FA are by definition unobservable and any attempt to measure these latent constructs would inevitably be accompanied by a measurement error (Jöreskog, Olsson, and Wallentin, 2016: 287). These latent factors can, for example, be individuals' cognitive abilities, personality traits, etc.

To highlight the distinction as well as the apparent similarity between FA and PCA, I follow Jöreskog, Olsson, and Wallentin (2016). Start with Equation (3) for the specification of the FA. Given $A'A = I$, an alternative formulation of Equation (3) is $x = Ac$. Now, assume that we extract only $k < p$ components:

$$x = A_k c_k + z, \quad (5)$$

where A_k is a matrix formed by the first k eigenvectors in A, c_k is a vector of the first k linear combinations, and z is a vector representing the remaining $p - k$ linear combinations ignored; $z = A_{p-k} c_{p-k}$. From a regression perspective, Equation (5) can be viewed as a regression of the x on a set of uncorrelated variables $c_1, \dots, c_k$, with z as the vector of error terms. Equation (5) resembles the general framework for the FA model:

$$x = \Lambda\xi + \delta \quad (6)$$

where $\xi = (\xi_1, \dots, \xi_k)'$ denotes the vector of the k continuous latent factors, where $k < p$, and Λ denotes the matrix of the factor loadings.[10] The $\Lambda\xi$ is the common or shared variance of x, while $\delta = (\delta_1, \dots, \delta_p)'$ denotes the vector of unique variances of observed variables in x, which are independent of ξ. The latent factors ξs are supposed to account for all the intercorrelations among the observed variables, which implies that δ_i is independent of δ_j, $\forall\, i \neq j$. The latter assumption illustrates the fundamental difference between PCA and FA. In Equation (5), z_i is not independent of $z_j\ \forall\, i \neq j$, because they both have the vector of c_{p-k} in common.

It follows from Equation (6), that the covariance matrix of x is $\Sigma = \Lambda\Phi\Lambda' + \Psi$, where Φ denotes the covariance matrix of the latent factors, and Ψ represents the covariance matrix of δ, which is a diagonal matrix. The latent factors are specified to be independent from one another in the EFA. This independence assumption implies that Φ is an identity matrix. Whereas correlations among the latent factors are assumed to be present in CFA. Additionally, the parameters in the matrix of the factor loadings; Λ, are all unconstrained in EFA, whereas a subset of the $p \times k$ parameters in this matrix are restricted by a priori model imposed in the CFA. Different estimation methods yield to different fit functions. Nevertheless, all are based on the idea of minimizing the distance between the observed covariance matrix of x, denoted by S, and the model covariance matrix denoted Σ. Similar to PCA, the scores of the factors from EFA or CFA can be predicted, and be used for subsequent analyses.

[10] For sake of simplicity, both x and ξ are assumed to be measured in deviations from their mean.

3.4.5. Latent class logit models

Latent class models are a set of modeling techniques which assume that an unobservable heterogeneity exists that categorizes the population into homogenous subgroups (Masyn, 2013). I follow Train (2009) in the specifications below. Imagine we are interested in modelling individuals' choices between J alternatives of a product or service. In such cases, y_j can take 1, ..., J values, where j is arbitrarily assigned to each alternative. The idea behind the latent class logit (LCL) model is that individuals can be grouped into $s = 1, \dots, S$ different segments, where each segment has its own set of taste parameters.

Define the utility that i obtains from alternative j as $y_{ij}^* = x_{ij}\beta_s + e_{ij}$, where β_s is the taste parameter in segment s, and e_{ij} is the random error assumed to have a type-I extreme value distribution (or Gumbel distribution). Therefore, β can take S possible values, each with probability π_s that represents the share of population in segment s, where $\sum_{s=1}^{S} \pi_s = 1$. Then the conditional probability that individual i chooses alternative j given membership in segment s takes the form of multinomial logit (MNL) model:

$$P_i(j\,|s) = \frac{\exp(x_{ij}\,\beta_s)}{\sum_{l=1}^{J}\exp(x_{il}\beta_s)}, \quad j = 1, \dots, J \qquad (7).$$

The unconditional probability that i chooses j can be expressed as $P_i(j) = \sum_{s=1}^{S} \pi_s P_i(j\,|s)$.

The segment probabilities π_s are also determined by probabilities of MNL form, and can be specified to be a function of individual specific characteristics such as sociodemographic factors or personality traits.

Instead of the discrete distribution for β, one can assume a normal distribution to account for heterogeneity across all individuals. Such assumption yields a random parameter logit model (RPL) or mixed logit model. The RPL model captures more heterogeneity than the LCL model. However, RPL captures the heterogeneity by allowing the preference parameters to vary randomly across all individuals without explaining the source of it, while LCL is useful in determining the source and understanding the underlying structure of the preference heterogeneity among the consumers (Boxall and Adamowicz, 2002; Keane and Wasi, 2013). Boxall and Adamowicz (2002) argue that the heterogeneity explained by LCL model is more useful for policy makers and marketing strategies than the heterogeneity captured by RPL.

3.5. Summary of the papers

Table 3 summarizes the main objectives, key variables, data, statistical models, and key findings of each paper. Below, each paper is discussed in some more detail.

Paper I - Food values and personality traits: A comparative study between the United States and Norway (co-author: Kyrre Rickertsen)

Motivation. According to conceptual models of food decision making process (e.g., Furst et al., 1996), individuals' personality traits are among the factors that can influence preferences over relative importance of food-related values. For each individual, food values are arranged in order of importance on a continuum (Lusk and Briggeman, 2009). The relative importance of each food value has an impact on individuals' perception about the food, their choice motives, and strategies developed to make food-related decisions (Furst et al., 1996).

Objectives. The main objective of this paper is to explore the role of the Big Five traits in determining preferences over relative importance of the food values.

Data. The data was obtained from the OS conducted in Norway and the US in 2015.

Measurements and methods. The Big Five personality traits were measured using BFI-20, and the five traits were calculated from the average scores of the associated items. The relative importance of the food values was elicited using BWS method. The LCL model was used in the analysis.

Results. Six distinct segments were found in each country. Four segments were relatively similar across the countries and these segments were given identical names: health, altruistic, rational, and hedonistic. In the health segment, safety, nutrition, and naturalness were the most important food values. For the altruistic segment, safety, naturalness, environmental impacts, and animal welfare were the most important food values. In the rational segment, price, taste, and safety were the most important food values, while in the hedonistic segment, taste was the most important food value. A natural segment and a welfare segment were specific to Norway. In the natural segment, origin, naturalness, and safety were most important. In the welfare segment, animal welfare and safety were the most important values. A safety segment and an indeterminate segment were specific to the US.

In the safety segment, safety was the only important food value. In the indeterminate segment, all food values were more or less equally important. Higher scores of openness to experience and agreeableness increased the probability of membership in altruistic segment in Norway and the US, and the welfare segment in Norway. Extraversion reduced the probability of membership in the welfare and the altruistic segments, and agreeableness increased the probability of membership in the natural segment in Norway. Openness to experience increased the probability of membership in the health and the rational segments in the US.

Implications. These findings imply that after sociodemographic variables are controlled for, personality traits influence individuals' preferences for food values. Openness to experiences and agreeableness were associated with food values concerning the societal and environmental impacts of food in both countries.

Paper II - Personality traits, knowledge, and consumer acceptance of genetically modified plant and animal products (co-author Kyrre Rickertsen)

Motivation. Several studies have investigated the barriers against the acceptance of GM food. However, the role of personality traits in determining attitudes towards these products have not been much investigated. Additionally, it has been argued that restrictive policies towards genetic modification can have a negative impact on the preferences for these products (Lusk, 2011b), which also is supported by empirical findings (Pakseresht, McFadden, and Lagerkvist, 2017). Currently no GM product is produced, sold, or used as feed in Norway (Mattilsynet, 2020).

Objectives. This paper has two main objectives. The first objective is to examine how the Big Five personality traits and lack of knowledge about GM food restrictions in Norway influence the stated WTP to avoid GM soybean oil, GM-fed salmon, and GM salmon. The second objective is to explore whether the personality traits are associated with the probability of holding an incorrect knowledge about the application of gene modification technologies in Norwegian agriculture.

Data. The data was obtained from the NMS conducted in Norway in 2015.

Measurements, and methods. The Big Five personality traits were measured using BFI-20, and the five traits were calculated from a CFA model. Demographic and socio-economic factors, trust in food information offices, and attitudes towards food's naturalness, and general attitudes towards environment were controlled for. Interval regression and probit models were used in the analysis.

Results. The importance of food's naturalness was strongly associated with GM aversion, while lack of knowledge about current restrictions on genetic engineering in Norwegian agriculture was associated with GM food acceptance. Conscientiousness was associated with GM acceptance, and agreeableness was associated with GM aversion for two of the GM foods. Neuroticism was associated with GM acceptance of one of the GM products. Conscientiousness was associated with a higher probability of having an incorrect knowledge about application of gene modification technologies in Norwegian agriculture, while agreeableness was associated with a lower probability of having this incorrect knowledge.

Implications. The findings suggest that restrictions against application of GM technologies can influence attitudes towards GM foods, and for those who are GM averse, lack of naturalness may be the greatest barrier against GM foods. Although personality traits explain some of individuals' preference heterogeneity, the results imply that the associations between personality traits and attitudes towards GM food are quite small and not consistent across products.

Paper III - Food values, personality traits and attitudes towards genetically modified food (co-author Kyrre Rickertsen)

Motivation. Individuals' a priori beliefs about GM food had been found to be an important factor in determining the attitudes towards these products. However, the literature has paid less attention to measure these a priori beliefs (Lusk, Roosen, and Bieberstein, 2014). Beliefs may be reflected by food specific values that are based on overall life values. The relationship between these food specific values and attitudes towards a food product can reveal individuals' subjective beliefs about these products (Lusk, 2011a; Pappalardo and Lusk, 2016).

Objectives. The objective of this paper is to explore the effects of personality traits and subjective beliefs on the WTP to avoid the three GM foods that also were used in paper (II).
Data. The data was obtained from the OS conducted in Norway and the US in 2015.
Measurements, and methods. The Big Five personality traits were measured using BFI-20, and the five traits were calculated from the average scores of the associated items. Subjective beliefs were measured by the associations between relative importance of food values and the WTP to avoid GM food. The relative importance of the food values was elicited using BWS method. An interval regression model was used for the analysis.
Results. Personality was not associated with attitudes towards GM food in Norway. In the US, agreeableness was associated with GM food acceptance and extraversion was associated with GM food aversion. Price is the most important motivation behind acceptance of GM food in both countries, while societal and environmental impacts were the main drivers for avoiding GM foods. Safety was a concern among respondents from Norway but not the US.
Implications. The findings imply that consumers perceive conventional alternatives to be more natural, fair, and convenient. The conventional alternatives are also perceived to have better origin, more in compliance with animal welfare, better appearance and less environmental impacts. Given such perceptions, credible information is important. Information could address the potential environmental benefits of gene modification technologies, address that such technologies are equally natural as other breeding technologies, and that there is nothing inherent in gene modification technology that reduce animal welfare or fairness. Such information can be more effective than only focusing on the safety of GM foods.

Paper IV - Sustainable food consumers: Dietary patterns, motives, and personality traits

Motivation. A food system that secures food and nutrition for all in an economically, socially, and environmentally sustainable way is at the heart of United Nations' sustainable development goals (FAO, 2018). However, how to achieve this goal is not straightforward. The lack of consensus among researchers, organizations, and authorities, can result in consumers' demotivation and confusion about sustainable practices (Austgulen, 2014).

Objectives. This paper has two main objectives. The first objective is to investigate consumers' current dietary patterns, and evaluate these dietary patterns from a sustainability perspective. The second objective is to explore the role of the Big Five personality traits and food values associated with each dietary pattern.

Data. The data was obtained from the NMS conducted in Norway in 2015.

Measurements, and methods. The Big Five personality traits were measured using BFI-20, and the five traits were calculated from the average scores of the associated items. The importance of the food values was elicited using a simplified version of BWS method. Dietary patterns were obtained from a PCA of 314 food items from a food frequency questionnaire (FFQ) included in NMS. Associations between personality traits and food values within the detected dietary patterns were investigated using OLS regression analysis.

Results. Three dietary patterns were detected and evaluated according to sustainability recommendations provided by Øverby et al. (2017). The sustainable dietary pattern was high in consumption of fruits and vegetables, the traditional dietary pattern was high in consumption of fish and traditional Norwegian dishes, and the unsustainable dietary pattern was high in consumption of meat and ready meals and snacks. Openness to experience was associated with the sustainable diet, agreeableness was associated with the traditional diet, and extraversion was associated with the unsustainable diet. Environmental impact of the food was the most important motivation behind adopting the sustainable diet. Norwegian origin of the food was the most important motivation behind adopting the traditional diet. Price was the most important motivation behind adopting the unsustainable diet. Convenience was the most important barrier against adopting the sustainable diet, while it was the second most important value for adopting the unsustainable dietary pattern.

Implications. The findings indicate that consumers pursue different food values in adopting different dietary patterns. Disagreement about what constitutes a sustainable practice in the Norwegian food system is also reflected in the adopted dietary patterns. Effective instruments to encourage (discourage) the (un)sustainable dietary patterns could include: subsidizing (taxing) the (un)sustainable food items, personality targeted information to increase the familiarity with non-traditional and sustainable food items and to develop recipes that uses these food items in conventional Norwegian dishes.

4. Contributions, Implications, and Limitations

This thesis contributes to the literature on the role of personality traits and food values in determining consumers' food-related attitudes and behavior. In the following, I summarize some contributions and some implications of the overall results of the thesis.

Personality traits influence the preference structure for food values. As discussed in Gustavsen and Hegnes (2020a), associations between personalities and choices of products do not say much about the reasons why people eat what they eat. The relationships between personality traits and food values highlights some of the primary outcomes people with certain personality traits desire to gain from the food. However, consumer's preference structure is only to a limited degree determined by personality traits and food values seem to be more important. Given my results, research can benefit from including both constructs in the investigation of consumers' food-related behavior.

Our findings suggest that respondents' food consumption patterns reflect their differences in personalities and food values. Respondents with higher scores of openness to experience and agreeableness were more likely to assign higher importance to societal and environmental aspects of the food than to the hedonistic aspect in both countries. More open and agreeable Norwegians assigned higher importance to environmental impact, origin, animal welfare and fairness than to taste or price. These respondents also had more sustainable food consumption patterns than other respondents. Lusk and Briggeman (2009) suggested that differences in consumption patterns across countries can be explained and understood by the differences in food values. Given the consistency of the associations between personality traits and food values, and the importance of food values in adopting different dietary patterns, it is reasonable to assume that more open and agreeable individuals in the US also would adopt more sustainable consumption patterns. In fact, several empirical findings provide evidence for this argument. As presented earlier in Table 1, across seven different studies conducted in six different countries, openness to experiences and agreeableness were associated with generally healthier dietary patterns,[11]

[11] Most of these studies investigated consumers' dietary patterns from health and nutrition intake perspective. Although, there are several aspects to sustainability such as food waste, packaging, fair trade, local, etc., but recommendations for a healthy diet, such as limited consumption of meat and higher consumption of fruits and vegetables are usually in compliance with a recommended sustainable diet.

which correspond well with our results where these two traits were associated with naturalness and social and environmental impacts.

Such findings provide support for the importance of personality for psychological persuasion and tailored marketing according to personality traits such as low openness vs. high openness. Personality targeted marketing has been found to effectively increase positive attitudes, purchasing intention, and actual purchase of consumers products such as beauty products, mobile phone and applications (e.g., Hirsh, Kang, and Bodenhausen, 2012; Matz et al., 2017). Moreover, there is increasing evidence indicating that individuals' personality traits can be reliably predicted from their footprints in online platforms such as Facebook or Twitter (e.g., Whittingham, Boecker, Grygorczyk, 2020; Youyou, Kosinski, and Stillwell, 2015). Therefore, targeting consumers' according to their personality traits is becoming increasingly a more achievable goal given the increased online footprints of the population. Policy makers and health authorities could also potentially use this opportunity to develop (international) public health strategies to communicate tailormade health or sustainability messages that matches individuals' personality traits. In this way, they could create and establish societal and environmental values of the food system and promote sustainable food consumption patterns.

The role of personality traits in determining WTP to avoid the three GM foods considered in this thesis were neither consistent across products nor samples. There may be at least three possible explanations. First, the non-replication of the findings across two different Norwegian samples could be the result of differences between the data collection methods, the differences between the demographic characteristics, and differences in preferences between the two samples. For example, average premiums to avoid GM food in the sample from NMS is around 18%, while it is around 9% in the sample obtained from the OS in Norway. Second, non-replication of the results across countries could be due to cultural differences, economic differences (e.g., income distribution), and policy environment. Third, the inconsistent relationships between personality traits and attitudes towards GM food may indicate that attitudes towards GM food are affected by several situation-specific and product-specific factors.

In the first section, we discussed Mischel's (2004) article about the "if … then …" interactions of situation and behavior and the existence of such nonlinearities. Empirical

findings suggest that when such nonlinearities exist behavioral patterns might be less consistent across situations (Borkenau et al., 2004; Epstein, 1979). Mischel (2004) indicates that individuals with the same personality traits might act differently across situations because they experience the situations differently. GM food is still a much-debated controversial topic, and two individuals with equal scores on conscientiousness might develop different attitudes towards GM food because they might support different ideas or political parties or live in two different policy environments. As indicated by Table 2 earlier, inconsistent and or non-replication of the associations between personality traits and attitudes towards GM food have been found before. This is while associations between personality traits and individuals' dietary patterns presented in Table 1, and the associations between personality traits and the relative importance of the food values as described in paper (I) were found to be relatively consistent across samples or countries.

These results may suggest that when the behavior or attitude is expected to be situation-specific, the role of personality traits can be better understood using constructs that are conceptually closer to the attitude or behavior. This is especially the case if the food is novel with new aspects. For example, Nystrand, Olsen, and Tudoran (2020) used structural equation modelling and found that the effect of personality traits on attitudes towards consumption frequency of functional food is mediated by individuals' consideration of future outcomes. Personality traits might also impact attitudes towards GM food through mediators that can capture situation-behavior nonlinearities. Moreover, Lusk, McFadden, and Wilson (2018) point that the term GM or GMO (genetically modified organisms) does no longer have a single definition, rather it refers to a range of technologies. Therefore, to measure attitudes towards GM food or application of gene modification technologies new questions with more details must be asked (Lusk, McFadden, and Wilson, 2018).

Finally, compared with the US, Norway has very restrictive policies towards GM foods. When Norwegian respondents are unaware of the current domestic regulations, they have lower WTP to avoid GM food. Moreover, while safety is no longer a big concern among the US consumers, Norwegian consumers are still concerned about safety of GM foods. These results support the suggestions made in the literature (Lusk, 2011b), where it is discussed how consumers interpret the restrictions against genetic modification technologies as a

potential hazard attributed to these products. Given less restrictive public policies, consumers' safety concerns about GM food might decrease.

This thesis must be read in light of its limitation. First, our results are based on stated preference methods with no real-life consequences, and as suggested in the literature the results may suffer from a hypothetical bias. Second, the data used in this thesis were based on self-reported measures. Moreover, the data did not allow for controlling for social desirability, which can be another source of bias in the results. Third, the questions used to measure attitudes towards GM food do not allow for stating any positive premium for the GM products, which could have potentially censored the positive attitudes towards GM food. Fourth, the version of the BFI model used in this thesis only included 20 items. Larger versions of the BFI may include more than 100 items. More nuanced results by using larger versions might be obtained. Moreover, extensive versions of the BFI allow for differentiating between the facets associated with each trait. It has been suggested that more accurate assessment of the empirical connections between Big Five traits and behavior can be obtained by investigating the role of facets. Finally, the importance of food values in NMS data set was not obtained from repeated choice experiments, but rather a simplified, one-time BWS method. Literature suggests that several factors such as order, size of choice set, time pressure, etc., can potentially affect the results. In addition, this one-time BWS does not allow for calculation of the importance scores that are obtained as a result of consumers' trade-offs between different food values in repeated choice tasks. However, it would be more costly to integrate longer versions of BFI or repeated choice tasks in surveys covering many topics such as NMS.

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Paper I

Food values and personality traits: A comparative study between the United States and Norway

Aida T. Ardebili and Kyrre Rickertsen

Abstract

The associations between food values and personality traits have been little investigated. We used an online survey to investigate these associations among consumers in Norway and the US. The preferences for twelve food values were elicited by the best-worst scaling method. A latent class logit model was used to construct six segments with homogenous preferences within each segment in each country. Food safety was among the most important values in most segments in both countries. Four segments represented similar food values in both countries: a health segment who emphasized nutrition and naturalness, an altruistic segment who emphasized societal values of food, a rational segment who emphasized taste and price, and a hedonistic segment who emphasized taste. Two country-specific segments were detected: a natural and a welfare segment in Norway, and a safety and an indeterminate segment in the US. Personality traits were associated with preference heterogeneity in several segments. High scores on openness to experience and agreeableness increased the probabilities of belonging to the segments that emphasized societal values of food.

Keywords: Big Five, consumer preferences, food values, segmentation.

1. Introduction

Furst et al. (1996) developed a conceptual food choice model (FCM) to describe the development of the food choice process over time. The FCM categorizes the factors involved in this process into life course experiences, influences, and a personal system. An individual is exposed to experiences over the life course that will shape the influences of food choices. Important influences include ideals, resources, and personal factors. These influences will

through recurring food choice events generate a personal system that consists of two major components: value negotiations and strategies. Value negotiations refer to the evaluation and arrangement of values important to the individual when reflecting on his/her food choices. Sensory perceptions, monetary considerations, convenience, health, nutrition, and quality are some of the most frequently mentioned values (Furst et al., 1996). In this paper, we investigate the associations between personality and a specific set of values that have been found to be important for food choices.

Individuals' response patterns to events and their consistent behaviors across different situations are summarized by their personality traits (Goldberg, 1993). Personality traits are considered to be endogenous basic tendencies (Costa and McCrae, 2001) that are uninfluenced by external factors, relatively stable over time (Asendorpf and Wilpers, 1998; Costa and McCrae, 1998), and to a significant extent biological (Jang et al., 1998). The Big Five personality traits are the most well-known taxonomy of traits (Goldberg, 1981). The five traits are: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (OCEAN).

Many studies have found significant effects of the OCEAN traits on food preferences. Some recent studies include Bazzani et al. (2017) who found that extraversion and agreeableness explained preference heterogeneity for local applesauce; Mora, Urdaneta, and Chaya (2019) who found that extraversion, agreeableness, and conscientiousness were associated with positive emotional responses, and neuroticism was associated with negative emotional responses in wine tasting; Gustavsen and Rickertsen (2019) who found that high scores on extraversion and openness to experiences increased the frequency of wine consumption and a high score on agreeableness reduced this frequency; Peschel et al. (2019) who found that respondents with high scores on openness and neuroticism had a preference for labels showing the production method; Ardebili and Rickertsen (2020) who found that conscientiousness was associated with acceptance of genetically modified food, and agreeableness was associated with aversion against these products; and Gustavsen and Hegnes (2020) who found that openness to experience is associated with positive attitudes and higher willingness to pay for organic food products. Machado-Oliveira et al. (2020) provide an overview of recent studies regarding personality traits and food consumption.

A value may be defined as: "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence" (Rokeach, 1973:5). In contrasts to personality traits, values are obtained and learned throughout life (Olver and Mooradian, 2003; Schwartz, 1994; Schwartz and Bilsky, 1990). Schwartz (1992) developed a comprehensive structure of basic value dimensions representing an individual's latent motivations and goals. He identified ten values: achievement, benevolence, conformity, hedonism, power, security, self-direction, stimulation, tradition, and universalism, and showed that these values had equivalent meaning across 20 countries with different cultures. These values may be interpreted as cognitive representations of biological needs, interactional requirements for interpersonal coordination, and societal demands for group welfare and survival (Schwartz and Bilsky, 1987).

Based on Schwartz's (1992) values and food-related literature, Lusk and Briggeman (2009) proposed a set of food values that could be directly linked to food choices. These food values were not interpreted to be directly connected to the abstract 'end-state of existence' as in Rokeach's (1973) general definition of a value, but were rather interpreted as an intermediary value system that consumers' would evaluate when they make their food choices (Lusk and Briggeman, 2009). Lusk and Briggeman (2009) suggested eleven food values: safety, nutrition, naturalness, environmental impact, taste, appearance, convenience, tradition, origin, fairness, and price. They discussed how these values revealed an individual's expectations about the outcome he or she wishes to achieve by consuming food products. As discussed by Lusk and Briggeman (2009), several of these food values are related to Schwartz's values. For example, food values such as environmental impact and fairness correspond to benevolence and universalism, taste and appearance correspond to hedonism, food safety corresponds to security, and lower concerns about naturalness and application of new technologies to food products correspond to stimulation. Several of these food values also correspond well with the values discussed in the FCM (Furst et al., 1996).

The importance of food values has been investigated in some studies. Lusk and Briggeman (2009) found that among 176 US respondents, safety was the most important value, followed by price, taste, and nutrition. Lister et al. (2017) investigated the relative importance of a set of food values similar to those proposed by Lusk and Briggeman (2009)

for ground beef, beef steak, chicken breast, and milk. Their results from 1,950 US respondents indicated that the most and least important food values were stable across these products. In particular, freshness, safety, taste, and health were among the most important, and animal welfare, environment, convenience, and origin were among the least important food values. Among 708 Spanish respondents, taste, safety, and price were ranked as much more important than fairness and environmental impact (Gómez-Cantó, Martínez-Ruiz, and Izquierdo-Yusta, 2018). Bazzani et al. (2018) compared food values in the US and Norway and found that food safety was most important among 1,025 US, and 1,037 Norwegian respondents. The most important difference between the respondents in the two countries was the importance of price. Price was the second most important food value in the US, while it was only ranked sixth in Norway.

Food values have also been found to be associated with preferences, demand, and willingness to pay (WTP). High importance of the values environmental impact and tradition have been associated with increased demand for organic milk and eggs (Lusk, 2011); high importance of taste, appearance, and novelty have been associated with increased demand for steak and ground beef (Tonsor, Lusk, and Schroeder, 2018); and high importance of healthiness have been associated with increased WTP for a new functional snack product (Pappalardo and Lusk, 2016).

Many studies have investigated associations between the OCEAN traits and Schwartz's values (e.g., Haslam, Whelan, and Bastian, 2009; Roccas et al., 2002). In a meta-analysis, Parks-Leduc, Feldman, and Bardi (2015) found that openness to experience and agreeableness showed stronger associations with values than extraversion and conscientiousness, while neuroticism was unrelated to Schwartz's values.

Personality and values are important components of the FCM. In this paper, we investigate the associations between personality traits and food values. The associations between the OCEAN traits and food values have not been studied before. We use a latent class logit (LCL) model where individuals are segmented based on the relative importance they assign to different food values. We use the same data set as Bazzani et al. (2018), however, our study offers two contributions as compared with this study. First, Bazzani et al. (2018) did not investigate the importance of personality traits for food values. Second, they used a random parameter logit (RPL) model to estimate the relative importance of the

food values while we use a LCL model. A RPL model accounts for heterogeneity by allowing the parameters to vary randomly across all respondents, while a LCL model accounts for heterogeneity by creating latent segments of respondents with homogenous within-segment preferences (Boxall and Adamowicz 2002). These segments may be useful for policy or marketing purposes.

2. Materials and Methods

2.1. The survey

An online survey was conducted in October and November 2015 in Norway and the US. The survey was conducted by a market research agency (Ipsos), who randomly recruited respondents across regions in both countries.[1] More than 1,000 respondents participated in each country (1,037 in Norway and 1,025 in the US). The respondents could quit the survey whenever they wanted and were assured that their information was anonymous. The survey included a choice experiment on food values and questions about socio-economic and demographic factors, attitudes, and personality traits.

2.2. Measurements of variables

We used the food values presented in Bazzani et al. (2018), and these values are shown in Table 1. The OCEAN traits were measured by the Big Five Inventory (BFI) model using the 20 items shown in Table 2.[2] The BFI-20 version is beneficial in situations where time is limited such as large-scale surveys (Engvik and Clausen, 2011). Items were measured by self-reported scores on a scale from 1 (the item does not describe the respondent at all) to 7 (the item describes the respondent very well). The Norwegian version of the items were used in the survey in Norway and the English version was used in the US survey. Each of the OCEAN traits was constructed from the mean values of the four items associated with the trait as shown in Table 2.

[1] More information can be found in https://www.ipsos.com/nb-no/samfunnsundersokelsen-norsk-monitor
[2] The BFI-20 version is based on BFI-44, which was developed by John, Donahue, and Kentle (1991). After a Norwegian translation of the BFI-44 was shown to have acceptable psychometric properties (Engvik and Føllesdal, 2005), this shorter version of the model was proposed and validated by Engvik and Clausen (2011).

Table 3 reports the mean values with standard deviations in the parentheses of the OCEAN traits for Norway and the US and Cronbach's alpha values for each trait in Norway and the US. These alpha values represent scale reliability coefficients of the standardized items and values above 0.60 suggest construct reliability (Hair et al., 2014: 619). In the last column, Cronbach's alpha values as reported in Engvik and Clausen (2011) are shown. The results indicate that except for conscientiousness in Norway, the constructed scales have an acceptable degree of reliability. The low alpha reliability coefficient for conscientiousness in Norway is similar to the value reported in Engvik and Clausen (2011). The mean values show higher scores for conscientiousness, extraversion, and agreeableness in Norway. For openness to experiences and neuroticism, the scores are higher in the US.

Table 4 reports the correlation matrix of the OCEAN traits in each country. An asterisk indicates a correlation that is significantly different from zero at the 5% level of significance. Although several correlations are significant, they are relatively low and the highest correlation is 0.49. To ease the interpretation in the subsequent analyses, we standardized each trait to have zero mean and unit standard deviation and used these standardized traits in the rest of the article.

Table 1. Food values

Food value	Description
Naturalness	Made without modern food technologies like genetic engineering, hormone treatment and food irradiation
Safety	Eating the food will not make you sick
Environmental impact	Effects of food production on the environment
Origin	Whether the food is produced locally, in the US/Norway or abroad
Fairness	Farmers, processors and retailers get a fair share of the price
Nutrition	Amount and type of fat, protein, etc.
Taste	The flavor of the food in your mouth
Appearance	The food looks appealing and appetizing
Convenience	How easy and fast the food is to cook and eat
Price	Price you pay for the food
Animal welfare	Well-being of farm animals
Novelty	The food is something new that you have not tried before

Source: The food values and their definition are adopted from Table 2 in Bazzani et al. (2018).

Table 2. The Big Five personality traits

Trait	APA definition [a]	Items [b]
Openness to experience	The tendency to be open to new aesthetic, cultural, or intellectual experiences	• Original with new ideas • Lively imagination • Likes to speculate and play with ideas • Few artistic interests
Conscientiousness	The tendency to be organized, responsible, and hardworking	• Do a thorough job • Careless • Usually have a messy life • Make plans and follow them up
Extraversion	An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience	• Talkative • Tends to be quiet • Shy • Outgoing and social
Agreeableness	The tendency to act in a cooperative, unselfish manner	• Helpful and selfless towards others • Can be cold and aloof • Considerate and friendly to most people • May sometimes be rude
Neuroticism	A chronic level of emotional instability and proneness to psychological distress	• Depressed • Relaxed, cope well with stress • Worries too much • Gets nervous easily

Source: The table is identical to Table 1 in Ardebili and Rickertsen (2020) who adopted the table from Almlund et al. (2011).
Notes: [a] Definitions according to American Psychology Association's (APA) dictionary of psychology (APA, 2007). [b] Items are adjusted based on BFI-20 developed by Engvik and Clausen (2011).

We included the demographic and socio-economic variables presented in Table 5 in the analysis. There were some important differences between the two samples. The mean age of the respondents was substantially higher in Norway (53 years) than in the US (40 years). In Norway a higher proportion of the respondents had a university degree (63% vs. 40% in the US), and were married or lived with a cohabitant (69% vs. 56% in the US).

Moreover, a higher proportion of the Norwegian respondents belonged to the high-income group (77% vs. 44% in the US), lived in rural areas (25% vs. 18% in the US), and lived or had lived on a farm (31% vs. 19% in the US). The characteristic of the samples and their representativity for the general population are discussed in more detail in Bazzani et al. (2018).

Table 3. Descriptive statistics and scale reliability of the OCEAN traits

	Norway (n= 1,037)		US (n= 1,026)		
	Mean [a] (SD)	Alpha [b]	Mean [a] (SD)	Alpha [b]	Alpha [c]
Openness to experience	4.31 (1.13)	0.72	4.79 (1.02)	0.61	0.63
Conscientiousness	5.16 (0.86)	0.55	5.05 (1.07)	0.64	0.57
Extraversion	4.50 (1.20)	0.81	4.08 (1.23)	0.71	0.78
Agreeableness	5.24 (0.90)	0.65	5.11 (1.07)	0.68	0.63
Neuroticism	3.01 (1.15)	0.75	3.66 (1.32)	0.74	0.73

Notes: [a] Mean values with standard deviations in the parentheses. Each trait was constructed from the mean values of the four items associated with the trait. [b] Cronbach's alpha values represent scale reliability coefficients of the standardized items. [c] Cronbach's alpha values as reported by the developers of the BFI-20 (Engvik and Clausen, 2011).

Table 4. Correlation matrix of the OCEAN traits, Norway and the US

	O	C	E	A	N
Norway (n= 1,037)					
Openness	1.00				
Conscientiousness	-0.01	1.00			
Extraversion	0.17*	0.11*	1.00		
Agreeableness	0.05	0.38*	0.30*	1.00	
Neuroticism	-0.09*	-0.23*	-0.31*	-0.23*	1.00
US (n= 1,026)					
Openness	1.00				
Conscientiousness	0.25*	1.00			
Extraversion	0.23*	0.21*	1.00		
Agreeableness	0.28*	0.49*	0.16*	1.00	
Neuroticism	-0.17*	-0.43*	-0.31*	-0.29*	1.00

Notes: An asterisk indicates significance at the 5% significance level.

Table 5. Definitions and mean values of the socioeconomic variables

Variable	Definition	Norway (n= 1,037)	US (n= 1,026)
Age	Age in years	53.53	40.39
Gender	= 1 if female	0.50	0.51
Education	= 1 if had a university degree or above	0.63	0.40
Marital status	= 1 if married or live with cohabitant	0.69	0.56
Children	= 1 if had one or more children living in the household	0.30	0.45
Income [a]	= 1 if earned > $62,500 in Norway or $60,000 in the US	0.77	0.44
Rural	= 1 if living in areas with < 100,000 residents	0.25	0.18
Farm	= 1 if live/have lived on a farm	0.31	0.19

Notes: [a] Gross annual income was recorded in intervals. The median income in the Norwegian and the US samples were $61,387 and $53,718, respectively. The exchange rate during the survey (October, 2015) was $1 ≈ NOK 8.00, which was used to convert the Norwegian income to US$.

2.3. Best-worst scaling method

The importance of each food value was elicited using the best-worst-scaling (BWS) method developed by Finn and Louviere (1992). In this method, respondents are faced with repeated choice sets and are asked to choose the best and the worst alternative rather than to rank all the alternatives. Flynn and Marley (2014) discussed three advantages of BWS as compared with other rating scales. First, it forces the respondent to discriminate between the alternatives, and one does not end up with a large proportion of respondents who rank many attributes either as very important or unimportant. Second, the method does not suffer from an interpretation problem, which may affect rating scales with unknown units of measurement. Third, for rating scales without physical units of measurements, the scores will be subjective and not uniform while the best and worst option has a uniform meaning for all respondents. The use of BWS has become more common, and a more detailed review of the method is provided in, for example, Bazzani et al. (2018).

A balanced incomplete block design (BIBD) is commonly used in BWS experiments. However, to avoid large choice sets or an excessive number of choice sets, a nearly balanced incomplete block design (NBIBD) is used. Each set included a subset of four food values, and each food value was repeated four times across the sets. Each respondent was faced with 12

choice sets, and each value was paired with other values 1.09 number of times.[3] Figure 1 shows an example of a choice set used in the survey.

Figure 1. Example of a choice set

Which of the following attributes is most important and which is least important when you purchase food? Please, check only one attribute as the most important and only one attribute as the least important.		
Most Important ONE ANSWER	Attribute	Least Important ONE ANSWER
☐	Appearance (the food looks appealing and appetizing)	☐
☐	Novelty (the food is something new that you have not tried before)	☐
☐	Fairness (farmers, processors and retailers get a fair share of the price)	☐
☐	Origin (whether the food is produced locally, in the US or abroad)	☐

Source: This is similar to Figure 1 in Bazzani et al. (2018).

2.4. Latent class logit model

We followed Lusk and Briggeman (2009) and Bazzani et al. (2018) and used a maxdiff model. Marley and Louviere (2005) developed this model, explained the consistency with random utility theory and the similarity with the multinomial logit (MNL) model (McFadden, 1974).

In the maxdiff model, it is assumed that the food values are aligned on an underlying scale of importance.[4] A respondent picks the pair of the most and the least important food values. Let $n = 1, \dots, N$ denote respondents, $t = 1, \dots, T$ choice sets, and $j = 1, \dots, J$ food values. In a choice set t, the true unobserved level of importance of food value j for

[3] In BIBD, choice sets are equally sized, i.e., each choice set includes an equal number of items, each item occurs the same number of times across the choice scenarios, and items are assigned orthogonally to each set, i.e., each item is paired with other items an equal number of times. Moreover, the number of times an item occurs across the choice sets, and number of times an item is paired with other items are integers. However, this design might be difficult to implement if one is unwilling to have large choice sets or numerous and repeated choice sets.

[4] To be consistent with the terminology used in Lusk and Briggeman (2009), we use the term scale of importance, which also could be interpreted as scale of utility.

respondent n is $I_{nj} = \lambda_j + \varepsilon_{nj}$, where λ_j denotes the location of food value j on the underlying scale of importance and ε_{nj} is an error term. This error term is assumed to be independently and identically (IID) distributed with a type I extreme value distribution. In each choice set, respondent n chooses the pair $\{j, k\}$ as the best and worst food values such that $I_{nj} - I_{nk} > I_{nl} - I_{nm}$, $\forall\, j \neq l$ and $k \neq m$.

We estimated the relative importance of the food values using a LCL model. In this model, it is assumed that there exist different classes or segments of respondents with homogenous preferences within each segment and heterogeneous preferences across the segments. Following Keane and Wasi (2013) and Train (2009), we assumed that there exists $s = 1, \dots, S$ segments of respondents. Let λ_{sj} denote the importance of food value j among the respondents in segment s. The probability of membership in segment s is π_s where $\sum_{s=1}^{S} \pi_s = 1$, and the (conditional) joint probability of respondent n's choices of the best and worst pairs $\{j, k\}$ in a sequence of choice sets given that he/she belongs to segment s is:

$$P_{n|s}(\lambda_s) = \prod_{t=1}^{T} \prod_{j=1}^{J} \prod_{k=1}^{J} \left(\frac{e^{\lambda_{sj} - \lambda_{sk}}}{\sum_{l=1}^{J} \sum_{m=1}^{J} e^{\lambda_{sl} - \lambda_{sm}}} \right)^{y_{njkt}} \quad \forall\, k \neq j \;\&\; l \neq m \tag{1}$$

where the estimated parameter λ_{sj} reflects the importance of the food value j in segment s relative to a food value whose importance is normalized to zero for identification purposes. Let $y_{njkt} = 1$ if respondent n chooses the pair $\{j, k\}$ and $y_{njkt} = 0$ for all other $J(J-1) - 1$ pairs in choice set t. The relative importance of the food values were estimated by maximizing the likelihood function:

$$L(\lambda) = \prod_{n=1}^{N} \sum_{s=1}^{S} \pi_s \, P_{n|s}(\lambda_S). \tag{2}$$

Following Boxall and Adamowicz (2002), the respondent's characteristics were used to predict segment membership and explain preference heterogeneity. The latent membership of respondent n in segment s was defined as $M_{ns}^{*} = \beta_s Z_n + \zeta_{ns}$, where Z_n is a vector of the respondent's characteristics such as demographic and socio-economic factors and personality traits, β_s is the associated parameter vector, and ζ_{ns} is an IID error term with type I extreme value distribution.

The probability of membership in segment s for respondent n was calculated by inserting $\beta_s Z_n$ into the expression for probabilities in a MNL model:

$$\pi_{ns}(\beta_s) = \frac{e^{\beta_s Z_n}}{\sum_{s=1}^{S} e^{\beta_s Z_n}} \tag{3}$$

where one segment was normalized to be zero for identification purposes. In this MNL model, the characteristics of the respondents generated the probabilities of belonging to the latent segments, which had been determined by the importance of the food values. Exponentiating the parameters in the model indicate the relative risk ratios (RRRs). The RRRs show the ratio of the probabilities of membership in segment *s* relative to the reference segment, before and after a one unit increase in the associated variable in Z_n. A RRR > 1 indicates an increased probability of belonging to segment *s* as compared with the reference segment after the relevant variable has increased by one unit, and a RRR < 1 indicates the opposite. We estimated the LCL model using the -lclogit2- command and -lmlogit2- (Yoo, 2019) in StataMP/15.1 (StataCorp, 2017).

We followed Lusk and Briggeman (2009) and Bazzani et al. (2018) and calculated the preference shares for each food value in each segment as:

$$S_{sj} = \frac{e^{\lambda_{sj}}}{\sum_{k=1}^{J} e^{\lambda_{sk}}} \times 100 \quad (4)$$

where $S_{sj}$is the predicted percentage probability for choosing food value j as the most important value in segment s, and $\sum_{j=1}^{J} S_{sj} = 100$. If one preference share is twice as large as another, it can be interpreted as being twice as important.

The number of segments in the LCL model has to be determined. We chose the number of segments according to four criteria. First, the minimization of three relative fit measures: Akaike's information criterion (AIC), Bayesian information criterion (BIC), and approximate weight of evidence (AWE) where lower AIC, BIC, and AWE values are preferred. Second, entropy values, which measure the accuracy of classification and are between 0 and 1. Values above 0.8 indicate acceptable classification accuracy (Muthén, 2004: 361). Third, the mean segment assignment probabilities, which should be greater than 0.8 (Geiser, 2013: 269). Fourth, the size of segments and the parsimony principle. This criterion ruled out models which were preferred by other criteria but resulted in one or several small segments. Such small segments are indicators of segment over extraction (Masyn, 2013: 265), and a solution with fewer segments is preferred (Geiser, 2013: 269).

3. Results

In Section 3.1, we discuss the results that were used to determine the number of segments in each country. In Sections 3.2 and 3.3, we present the results of the selected model in each country. In the analysis, we followed Bazzani et al. (2018) and normalized the importance of the food value "novelty" to be zero. To save space and facilitate the comparisons of results, the predicted preference shares for each segment of the LCL model in Norway and the US are reported. The estimated parameters are not discussed in the text but the full estimation results are provided in Tables A1 and A2 in the Appendix.[5]

3.1. Segments in the LCL models

Tables 6 summarizes the estimation results for the four criteria used for choosing the number of segments in Norway and the US. The tables show the loglikelihood values at convergence, the total number of parameters in each model, the three relative fit statistics (AIC, BIC, and AWE), the mean assignment probabilities (Prob), the entropy values (E), and the number of segments with sample shares of less than 10% for models with two to eight segments (Share).

The AIC and BIC decreased as the number of the segments increased in both countries. However, the models with seven or eight segments resulted in one or more segments with sample shares of less than 10%. The AWE reached its minimum value for five segments in the US and six segments in Norway. There is little difference in the mean segment assignment probabilities and entropy values in either country between five and six segments. Based on these results, we decided to use six segments in both countries.

We gave each segment a name that reflected the most important food values in the segment and used identical names on similar segments in both countries. We have four segments with identical names in the two countries: Health, altruistic, hedonistic, and rational. In addition, we have a safety segment and an indeterminate segment in the US, and

[5] To ensure a global maximum, we set the maximum number of iterations to 10,000 and estimated the model several times using different starting values. The results reported in Appendix tables A1 and A2, were robust for different starting values.

a natural segment and a welfare segment in Norway.[6] We elaborate on the most important food values for each segment in the next section.

Table 6. Fit statistics for latent class logit models in Norway and the US

No of segments [a]	Log likelihood [b]	No. of parameters [c]	AIC [d]	BIC [e]	AWE [f]	Prob [g]	E [h]	Share [i]
Norway (n = 1,037)								
2	-23,088	36	46,248	46,426	46,784	0.97	0.89	0
3	-22,629	61	45,380	45,681	46,288	0.94	0.86	0
4	-22,208	86	44,588	45,013	45,868	0.93	0.87	0
5	-21,948	111	44,118	44,667	45,770	0.92	0.87	0
6	-21,704	136	43,680	44,352	45,704	0.92	0.87	0
7	-21,548	161	43,418	44,214	45,815	0.91	0.88	2
8	-21,411	186	43,193	44,113	45,963	0.90	0.87	3
US (n = 1,026)								
2	-24,914	36	49,899	50,077	50,434	0.97	0.88	0
3	-23,983	61	48,088	48,389	48,995	0.95	0.89	0
4	-23,586	86	47,345	47,769	48,623	0.93	0.88	0
5	-23,307	111	46,836	47,384	48,487	0.92	0.87	0
6	-23,099	136	46,470	47,140	48,492	0.92	0.88	0
7	-22,931	161	46,183	46,978	48,577	0.91	0.88	1
8	-22,831	186	46,034	46,952	48,800	0.90	0.87	2

Notes: [a] Number of segments in model for each country. [b] Log likelihood value at convergence. [c] Number of parameters estimated. [d]Akaike Information Criteria (AIC) was calculated as $\{-2(\mathrm{LL} - \text{no of parameters})\}$. [e] Bayesian Information Criterion (BIC) was calculated as $\{-2\mathrm{LL} + [\text{no of parameters} \times \ln(\text{no of respondents})]$. [f] Approximate Weight of Evidence (AWE) was calculated as $\{-2\mathrm{LL} + [2 \times \text{no of parameters} \times (\ln(\text{no of respondents}) + 1.5)]$. [g] Mean segments assignment probability. [h] Entropy value. [i] Number of segments with a share less than 10%.

3.2. Six segment model for Norway

Figure 2 shows the Norwegian predicted preference shares for each food value and the variables that significantly determined the membership of each segment. The percentage of respondents who belonged to the segment is shown in the parenthesis after the name of the segment. The bars represent the percentage preference shares for each food value in the

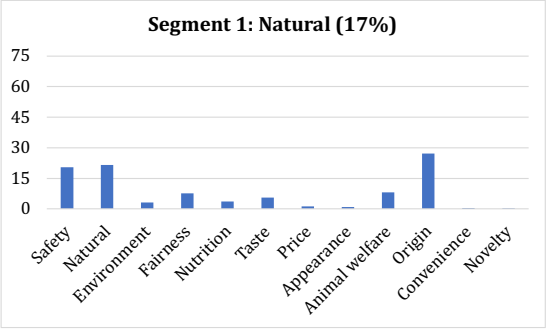
[6] We acknowledge that the names of the segments are subjective. We tried to select words that conveyed the most important food values in each segment. For example, health was selected as name for the segment where the nutritional value of food was of particular importance, and altruistic was selected as name for the segment where food values that focus on the wellbeing of other people were important. However, other names might also have captured essential food values in each segment. For example, safety was a dominant food value in many of the segments without being reflected in the names of the segments.

segment. A hatched bar indicates that the importance of the specific food value was not significantly different from the importance of novelty. To the right of each panel, the RRR values of each variable with a significant effect on segment membership are shown.

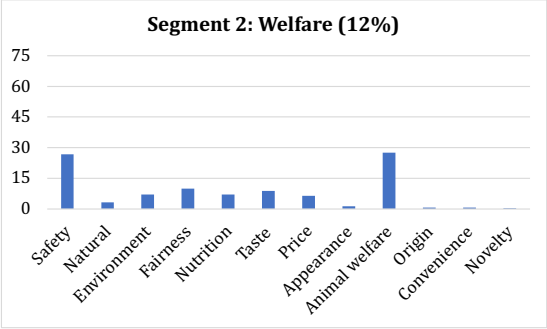
The natural segment consisted of 17% of the respondents. Origin, naturalness, and safety were the most important food values associated with this segment. The welfare segment consisted of 12%, and animal welfare was the most important value. Food safety and to some extent fairness were also important values. The health segment consisted of 21% and was one of the two largest segments. The dominant value was safety, and safety was more important in the health segment than for any other Norwegian segment. Nutrition was also important in this segment. The altruistic segment was as large as the health segment. Safety, naturalness, environmental impact, animal welfare, and fairness were almost equally important for this segment. The rational segment consisted of 19%. In this segment, main values were taste and price as predicted by basic economic theory. Taste and price were almost twice as important as safety. The hedonistic segment was the smallest with a 10% share. This segment valued taste above safety. The importance of price and convenience were not significantly different from the importance of novelty.

Demographic or socioeconomic variables were associated with the probability of membership in each segment. The hedonistic segment was the reference segment, and the effects are compared with probability of belonging to this segment. Females were about three times more likely than males to be in the altruistic segment as compared with the hedonistic segment. A one year increase in age reduced the probability of belonging to the welfare segment by 4% as compared with the hedonistic segment. Education was important for membership in several segments. Respondents with a university degree were more than three times more likely to be in the health segment and more than twice as likely to be in the altruistic or the rational segment as comparted with the hedonistic segment. Finally, respondents who live or had lived on a farm were almost four times more likely to belong to the natural segment and more than twice as likely to belong to the altruistic segment as compared with the hedonistic segment.

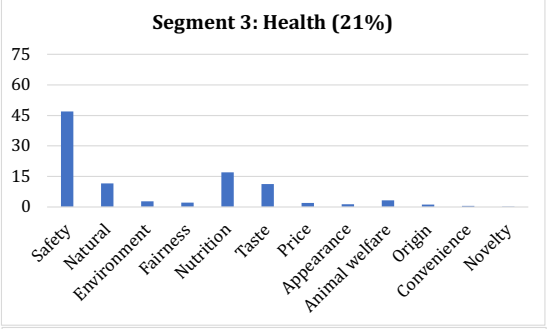
Figure 2. Preference shares for food values in each segment, Norway



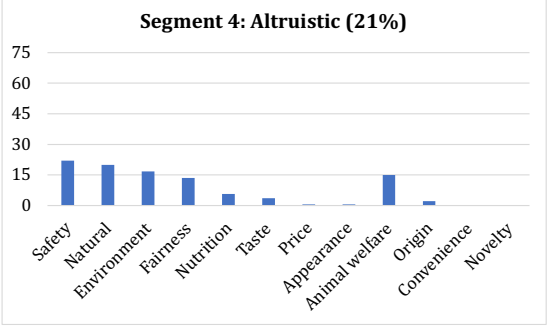
Significant variables	RRR
Farm	3.78
Agreeableness	1.48



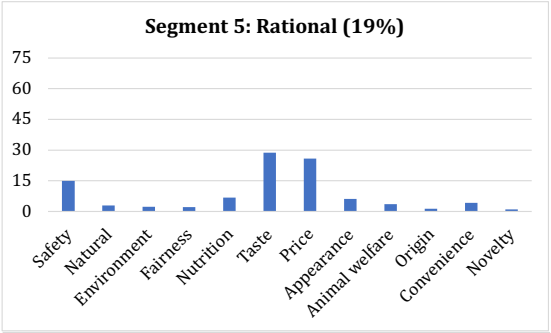
Significant variables	RRR
Age	0.96
Openness	1.63
Extraversion	0.68
Agreeableness	1.52



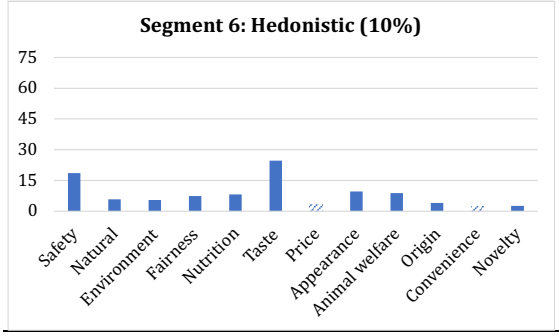
Significant variables	RRR
Education	3.25



Significant variables	RRR
Female	2.89
Education	2.18
Farm	2.53
Openness	1.75
Extraversion	0.64
Agreeableness	1.52



Significant variables	RRR
Education	2.34



Reference segment

Notes: The size (measured in percentage of the Norwegian sample) of each segment is provided in the parenthesis in each panel. The relative risk ratios (RRR) that were significant at the 5% level on segment membership is shown in the table on the right hand side of each panel. The bars with pattern fill indicate share of preference based on insignificant parameter for the food value.

There were seven significant effects of personality traits on the probabilities of belonging to the six segments. A one standard deviation increase in openness to experience increased the probabilities of belonging to the welfare and the altruistic segments by more than 60%. A one standard deviation increase in agreeableness increased the probabilities of belonging to the natural, welfare, or altruistic segments by around 50%. Finally, a one standard deviation increase in extraversion reduced the probabilities of belonging to the welfare or the altruistic segment by more than 30%.

3.3. Six segment model for the US

Figure 3 shows the results for the US respondents. Two country-specific segments were found. The safety segment consisted of 17% of the respondents. Safety was the dominant value with a 74% preference share. After safety, taste had some importance. The

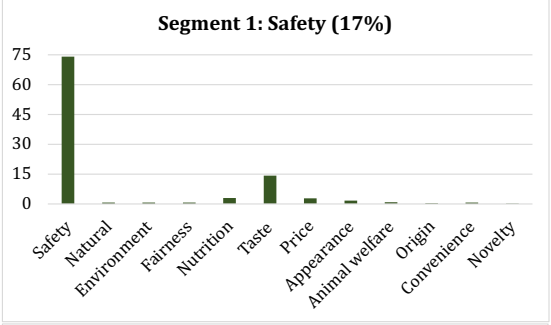
indeterminate segment consisted of 17%, and for these respondents no specific food values were important. The importance of fairness, appearance, origin, and convenience were not significantly different than the importance of novelty.[7] The health segment consisted of 18% and cared most about safety, but nutrition, naturalness, and taste were also important. The altruistic segment consisted of 19% and was the largest segment. Safety, animal welfare, naturalness, and environment were important. The rational segment was the smallest segment and consisted of 14%. Safety and price were equally important in this segment. The hedonistic segment consisted of 15%. This segment emphasized taste over price, and substantially higher than safety.

There were nine significant demographic and socioeconomic effects on segmentation. Females were around 2 to 3 times more likely than males to be in the safety, health, altruistic or the rational segments as compared with the hedonistic segment. A one year increase in the age of the respondent reduced the probability of belonging to the indeterminate segment by 5% and increased the probability of belonging to the rational segment by 3% as compared with the hedonistic segment. Respondents with a university degree had a 62% lower probability of belonging to the rational segment than to the hedonistic segment. Respondents in the high-income group were more than twice as likely to belong to the health segment as compared with the hedonistic segment. Finally, it was twice as likely that the respondents who live or had lived on a farm belonged to the indeterminate segment rather than the hedonistic segment.

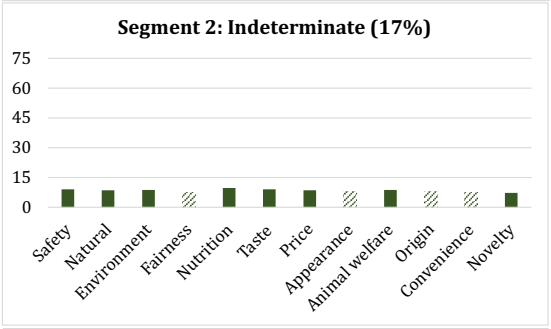
There were six significant effects of the personality traits on segmentation. A one standard deviation increase in openness to experience increased the probability of belonging to the health, altruistic, or rational segments by 45% to 80% as compared with probability of belonging to the hedonistic segment. Agreeableness increased the probability of belonging to the altruistic rather than hedonistic segment by 42%. Finally, a one standard deviation increase in agreeableness or conscientiousness halved the probability of belonging to the indeterminate segment as compared with the hedonistic segment.

[7] According to Yoo and Doiron (2013), such findings suggest a large error variance, which could imply inattentiveness or some complex causal evaluation rule among these respondents.

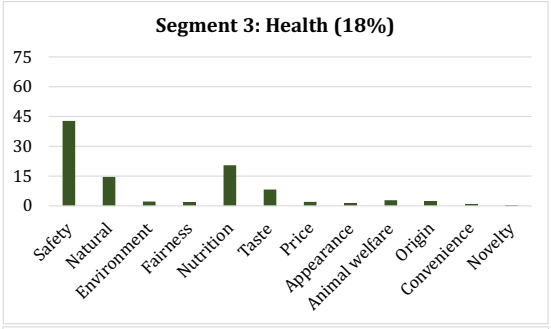
Figure 3. Preference shares for food values in each segment, the US



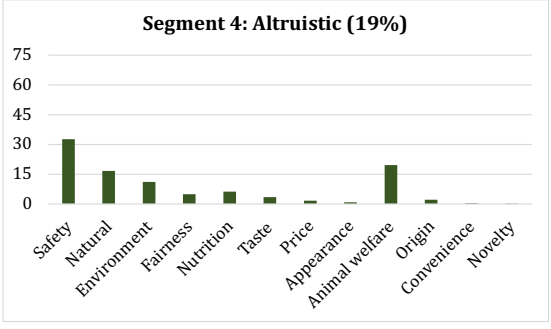
Significant variables	RRR
Female	2.15



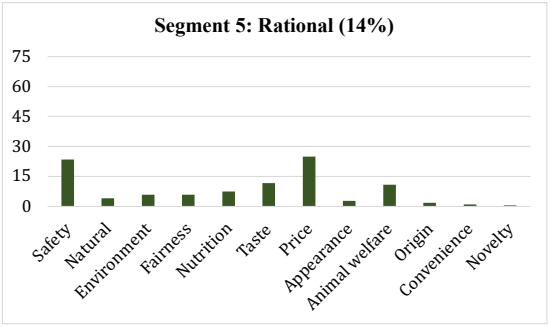
Significant variables	RRR
Age	0.95
Farm	2.05
Conscientiousness	0.50
Agreeableness	0.49



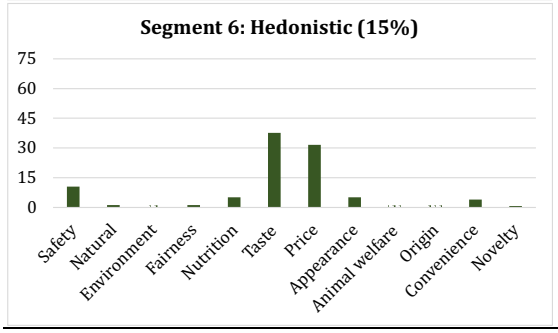
Significant variables	RRR
Female	1.81
Income	2.07
Openness	1.45



Significant variables	RRR
Female	2.81
Openness	1.80
Agreeableness	1.42



Significant variables	RRR
Female	2.27
Age	1.03
Education	0.38
Openness	1.55



Reference segment

Notes: The size (measured in percentage of the US sample) of each segment is provided in the parenthesis in each panel. The relative risk ratios (RRR) that were significant at the 5% level on segment membership is shown in the table on the right hand side of each panel. The bars with pattern fill indicate share of preference based on insignificant parameter for the food value.

4. Discussion

Corresponding to previous results, food safety was found to be one of the three most important food values in eleven out of twelve segments (e.g., Bazzani et al., 2018; Gómez-Cantó, Martínez-Ruiz, and Izquierdo-Yusta, 2018; Lusk and Briggeman, 2009). Safety was a bigger concern among the US than the Norwegian respondents. Safety was the most important food value in one Norwegian segment, while it was the most important value in four US segments. A larger proportion of US consumers may be worried about the safety of food as a consequence of food safety events (e.g., Tonsor, Mintert, and Schroeder, 2010) or more liberal policies towards controversial food technologies (Bovay and Alston, 2018). However, as pointed out by Verbeke (2005), the majority of consumers might be less anxious about food safety under normal conditions than after a food safety event.

Price was less important in Norway than in the US, and this difference may be due to differences in the income distribution as discussed in Bazzani et al. (2018). Only the rational segment (19%) emphasized price in Norway. In the US, price was an important value in the rational and hedonistic segments (total 42%).

The food values within each segment in both countries were similar for the health, altruistic, rational, and hedonistic segments. These segments included almost 70% of the respondents. In both countries, the health segment ranked safety first (about 45%), nutrition second (around 20%) and thereafter naturalness and taste. The altruistic segments consisted of respondents who did not emphasize taste and price but rather values that can be considered to be societal such as safety, animal welfare, naturalness, and environment. Fairness was also important in this segment in Norway. The rational and hedonistic segments were somewhat more different in the two countries. Taste, price, and safety were the three most important values in both countries. However, the importance of taste and price was twice as high as the importance of safety in Norway. In the US price was equally important as safety, taste was less important than safety and animal welfare also quite important. Taste was the most important value for the hedonistic segment in both countries. The hedonistic segment in the US valued taste over price while price was of no significant importance in Norway. As described above, the natural and welfare segments were specific for Norway and the safety and indeterminate segments were specific for the US.

Personality traits were associated with the food values in both countries. The only trait with no significant associations was neuroticism. There are two important similarities across the altruistic segment in both countries. Respondents with higher scores on openness to experience were more likely to belong to this segment, and respondents with higher scores on agreeableness were also more likely to belong to it. The important food values in the altruistic segment (i.e., safety, animal welfare, naturalness, environment, and fairness) are in line with the United Nations' sustainable development goals. Positive associations between openness and agreeableness with sustainable food consumption are in line with results from some previous studies. Gustavsen and Hegnes (2020) found positive associations between openness to experience and willingness to pay for organic food, and Grebitus and Dumortier (2016) found that higher scores on agreeableness were associated with higher demand for organic tomatoes. In addition, important food values for the

altruistic segments correspond well with the general values benevolence and universalism in Schwartz's value taxonomy. Benevolence and universalism reflect care for the welfare of people and nature (Schwartz, 1994), and several studies have found positive associations between openness to experience or agreeableness and the values benevolence and universalism (Olver and Mooradian, 2003; Parks-Leduc, Feldman, and Bardi, 2015).[8]

For the other segments, there were no consistent patterns in the effects of the personality traits across countries. Respondents with higher scores on openness to experience were more likely to belong to the Norwegian welfare segment, and the health and rational segments in the US. A high score on agreeableness was associated with membership in the welfare and the natural segments in Norway. Higher scores on extraversion decreased the probability of belonging to the altruistic or welfare segments in Norway. Finally, increased conscientiousness and agreeableness decreased the probability of membership in the indeterminate segment in the US. According to Yoo and Doiron (2013), lack of prioritizing could imply inattentiveness. Inattentiveness in responding to the online choice experiment could be the result of lack of discipline, thoroughness, or helpfulness, which are items under the personality traits conscientiousness and agreeableness.

General values are inherently cognitive and learned through the life cycle, while personality traits, interpreted as 'patterns of thoughts, feelings, and actions' (McCrae & Costa, 2003: 25), may be cognitively based (thoughts), behavioral based (actions), or emotionally based (feelings) (Parks-Leduc, Feldman, and Bardi, 2015; Zillig, Hemenover, and Dienstbier, 2002). Openness to experience and agreeableness are considered to be mostly cognitively based, and neuroticism is considered to be mostly emotionally based. Conscientiousness and extraversion are considered to be somewhere in between and mostly behavioral based (Parks-Leduc, Feldman, and Bardi, 2015; Zillig, Hemenover, and Dienstbier, 2002). Parks-Leduc, Feldman, and Bardi (2015) argue that the more cognitively based a trait is, the stronger it will be associated with individuals' values. This argument has been supported by empirical findings from studies based on neuroscience related to the Big Five and other empirical results (DeYoung et al., 2010; Olver and Mooradian; 2003; Parks-

[8] We acknowledge the differences between food values and Schwartz's values. However, due to correspondence between the food values and Schwartz's general values, we draw on several previous findings on the relationship between the Big Five personality traits and Schwartz's values.

Leduc, Feldman, and Bardi, 2015). Our results are also in line with these results. Ten out of the 13 significant effects of the personality traits on the food values are related to openness to experience and agreeableness and none is related to neuroticism.

Our findings have some implications. With increased availability of big data on individuals' online activities, several studies have shown that personality traits can be predicted from online behavior (e.g., Bachrach et al., 2012; Asadzadeh and Rahimi, 2017; Tadesse et al., 2018). Given the need for a transition towards more sustainable food consumption, businesses and policy makers can use big data to identify consumers' personality and communicate sustainability messages according to their personality traits. Our results specifically indicate that females and highly educated people with high scores on openness and agreeableness may be highly receptive to sustainability messages. Sustainable food consumption within these segments may then spillover to other segments over time. In a similar way, our results can be used to identify segments who emphasize food values such as taste, price, or nutrition.

This study has some limitations. First, our version of the BFI model only included 20 items. Larger versions of the BFI may include more than 100 items. One would expect more nuanced results by using larger versions, however, they would also be more difficult to integrate in surveys covering many topics or including many respondents. Second, there are some issues related to the sample sizes and the generalizability of the results. The US has a much larger population than Norway but the sample sizes were equal for both countries. In a quite heterogenous country like the US, there may be substantial regional differences that would be interesting to investigate. Finally, the demographics and socio-economic characteristics of our samples do not completely correspond to the populations in the two countries.

5. Conclusions

We have compared food consumers in Norway and the US, elicited their preferences for twelve food values, and mapped their personality traits. The data were analyzed using LCL model, which assumes heterogenous preferences across segments of respondents with homogenous preferences within each segment. The LCL model was useful in revealing the underlying structure of preference heterogeneity. The segments health, altruistic, rational,

and hedonistic were similar in the two countries. In addition, we found a welfare and a natural segment in Norway and an indeterminate and a safety segment in the US.

Our findings show that personality traits influence preferences for food values, and the understanding of food-related behavior may increase by integrating both constructs in future studies. Most of the significant effects of personality traits were related to openness to experience and agreeableness and none was related to neuroticism. In particular, in both countries high scores on openness to experiences and agreeableness were associated with belonging to the altruistic segment, which emphasized the societal values of food.

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Appendix (or for referees' use)

Table A1. Parameter estimates for latent class logit model, Norway (n = 1037) [a]

	Natural	Welfare	Health	Altruistic	Rational	Hedonistic
Safety	4.91*	4.57*	5.70*	5.61*	2.63*	2.00*
	(0.19)	(0.24)	(0.18)	(0.19)	(0.11)	(0.18)
Naturalness	4.97*	2.49*	4.29*	5.51*	0.97*	0.82*
	(0.19)	(0.19)	(0.17)	(0.18)	(0.09)	(0.14)
Environmental impact	3.03*	3.24*	2.87*	5.34*	0.76*	0.79*
	(0.16)	(0.20)	(0.14)	(0.19)	(0.10)	(0.13)
Fairness	3.93*	3.58*	2.62*	5.12*	0.65*	1.07*
	(0.17)	(0.20)	(0.14)	(0.18)	(0.10)	(0.13)
Nutrition	3.20*	3.22*	4.68*	4.26*	1.84*	1.17*
	(0.17)	(0.20)	(0.16)	(0.18)	(0.10)	(0.15)
Taste	3.60*	3.46*	4.27*	3.78*	3.28*	2.28*
	(0.16)	(0.19)	(0.15)	(0.17)	(0.12)	(0.17)
Price	2.07*	3.14*	2.48*	1.94*	3.18*	0.16
	(0.15)	(0.19)	(0.14)	(0.15)	(0.12)	(0.15)
Appearance	1.78*	1.54*	2.11*	1.75*	1.73*	1.34*
	(0.14)	(0.18)	(0.13)	(0.13)	(0.10)	(0.15)
Animal welfare	3.99*	4.60*	3.01*	5.22*	1.20*	1.26*
	(0.17)	(0.28)	(0.14)	(0.19)	(0.10)	(0.13)
Origin	5.19*	0.90*	1.92*	3.32*	0.29*	0.47*

	(0.10)	(0.17)	(0.13)	(0.17)	(0.10)	(0.14)
Convenience	1.17*	0.97*	1.38*	0.71*	1.36*	-0.17
	(0.10)	(0.15)	(0.13)	(0.11)	(0.10)	(0.15)
Female	0.57	0.01	0.49	1.06*	-0.12	0.00
	(0.31)	(0.35)	(0.31)	(0.30)	(0.30)	
Age	-0.01	-0.04*	-0.01	-0.01	-0.02	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Education	0.56	-0.22	1.18*	0.78*	0.85*	0.00
	(0.30)	(0.33)	(0.30)	(0.29)	(0.29)	
Marital status	0.50	0.16	0.29	0.28	0.29	0.00
	(0.34)	(0.36)	(0.33)	(0.32)	(0.32)	
Children	-0.17	-0.23	0.06	-0.09	-0.06	0.00
	(0.34)	(0.37)	(0.33)	(0.33)	(0.33)	
Income	-0.16	-0.60	0.06	-0.03	0.20	0.00
	(0.38)	(0.40)	(0.38)	(0.37)	(0.38)	
Rural	0.23	0.24	-0.05	0.21	-0.21	0.00
	(0.34)	(0.38)	(0.35)	(0.34)	(0.35)	
Farm	1.33*	0.33	0.41	0.93*	0.13	0.00
	(0.34)	(0.40)	(0.35)	(0.34)	(0.36)	
Openness	0.02	0.49*	0.05	0.56*	0.06	0.00
	(0.15)	(0.17)	(0.15)	(0.15)	(0.15)	
Conscientiousness	0.14	-0.10	0.15	0.04	0.15	0.00
	(0.16)	(0.18)	(0.16)	(0.15)	(0.16)	
Extraversion	-0.11	-0.39*	-0.26	-0.44*	-0.27	0.00
	(0.16)	(0.18)	(0.16)	(0.16)	(0.16)	
Agreeableness	0.39*	0.42*	0.27	0.42*	0.17	0.00
	(0.16)	(0.18)	(0.16)	(0.16)	(0.16)	
Neuroticism	0.26	0.29	0.19	0.24	0.26	0.00
	(0.17)	(0.18)	(0.17)	(0.16)	(0.16)	
Constant	-0.05	2.79*	-0.05	-0.24	1.02	0.00
	(0.76)	(0.73)	(0.75)	(0.75)	(0.73)	
Share in segment	0.17	0.12	0.21	0.21	0.19	0.10
Log likelihood		-21,704				
No of parameters		136				
AIC [b]		43,680				
BIC [c]		44,352				

Notes: [a] Standard errors in parentheses. An asterisk implies significance at the 5% level. Hedonistic is the reference segment. [b] Akaike Information Criterion calculated as $\{-2(LL - P)\}$ where LL is the log-likelihood value and P the number of parameters. [c] Bayesian Information Criterion calculated as $\{-2LL + [P \times \ln(\text{no of respondents})]$.

Table A2. Parameter estimates for latent class logit model, US (n = 1,026) [a]

	Safety	Indeterminate	Health	Altruistic	Rational	Hedonistic
Safety	6.64*	0.21*	4.73*	5.05*	3.83*	2.64*
	(0.28)	(0.08)	(0.19)	(0.15)	(0.19)	(0.15)
Naturalness	2.02*	0.16*	3.66*	4.38*	2.05*	0.53*
	(0.17)	(0.08)	(0.20)	(0.15)	(0.17)	(0.12)

Environmental impact	1.86* (0.18)	0.18* (0.08)	1.78* (0.13)	3.98* (0.14)	2.45* (0.16)	0.24 (0.13)
Fairness	2.02* (0.17)	0.04 (0.08)	1.58* (0.13)	3.18* (0.13)	2.43* (0.16)	0.46* (0.13)
Nutrition	3.41* (0.22)	0.29* (0.08)	3.99* (0.17)	3.41* (0.14)	2.67* (0.16)	1.92* (0.14)
Taste	4.99* (0.22)	0.23* (0.08)	3.08* (0.14)	2.83* (0.13)	3.12* (0.18)	3.92* (0.17)
Price	3.36* (0.21)	0.15* (0.08)	1.69* (0.13)	2.01* (0.13)	3.89* (0.21)	3.75* (0.17)
Appearance	2.90* (0.18)	0.08 (0.08)	1.24* (0.12)	1.41* (0.12)	1.67* (0.16)	1.93* (0.13)
Animal welfare	2.29* (0.19)	0.18* (0.08)	2.02* (0.15)	4.54* (0.15)	3.05* (0.17)	0.22 (0.14)
Origin	1.52* (0.16)	0.11 (0.08)	1.87* (0.14)	2.30* (0.14)	1.27* (0.16)	0.30* (0.12)
Convenience	1.97 * (0.16)	0.00 (0.08)	0.83* (0.10)	0.62* (0.10)	0.71* (0.13)	1.69* (0.13)
Female	0.77* (0.29)	-0.21 (0.28)	0.59* (0.27)	1.03* (0.27)	0.82* (0.31)	0.00
Age	0.01 (0.01)	-0.06* (0.01)	-0.00 (0.01)	0.00 (0.01)	0.03* (0.01)	0.00
Education	-0.07 (0.29)	-0.03 (0.29)	0.17 (0.27)	-0.24 (0.27)	-0.96* (0.36)	0.00
Marital status	0.25 (0.29)	0.32 (0.30)	0.18 (0.28)	0.49 (0.28)	-0.18 (0.31)	0.00
Children	0.30 (0.29)	0.15 (0.29)	0.47 (0.28)	0.44 (0.27)	0.15 (0.31)	0.00
Income	0.54 (0.30)	0.59 (0.30)	0.73* (0.29)	0.03 (0.29)	-0.32 (0.37)	0.00
Rural	-0.24 (0.35)	-0.05 (0.37)	0.11 (0.33)	-0.09 (0.32)	-0.06 (0.35)	0.00
Farm	0.20 (0.38)	0.72* (0.35)	0.47 (0.35)	0.17 (0.36)	0.60 (0.38)	0.00
Openness	0.04 (0.14)	0.22 (0.15)	0.37* (0.14)	0.59* (0.13)	0.44* (0.15)	0.00
Conscientiousness	0.27 (0.17)	-0.68* (0.18)	-0.07 (0.16)	0.13 (0.15)	-0.07 (0.17)	0.00
Extraversion	0.10 (0.14)	0.28 (0.16)	0.21 (0.14)	-0.00 (0.13)	-0.01 (0.15)	0.00
Agreeableness	0.21 (0.15)	-0.72* (0.17)	0.14 (0.15)	0.35* (0.15)	0.21 (0.16)	0.00
Neuroticism	-0.15 (0.16)	-0.29 (0.17)	-0.25 (0.15)	0.07 (0.14)	-0.08 (0.16)	0.00
Constant	-1.07 (0.57)	1.29* (0.50)	-0.73 (0.53)	-0.87 1.03*	-1.30* (0.60)	0.00
Share in segment	0.17	0.17	0.18	0.19	0.14	0.15
Log likelihood		-23,099				

No of parameters	136
AIC [b]	46,470
BIC [c]	47,141

Notes: [a] An asterisk implies significance at the 5% level. Hedonistic is the reference segment. [b] Akaike Information Criterion calculated as $\{-2(LL - P)\}$ where LL is the log-likelihood value and P the number of parameters. [c] Bayesian Information Criterion calculated as $\{-2LL + [P \times \ln(\text{no of respondents})]$.

Paper II

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Personality traits, knowledge, and consumer acceptance of genetically modified plant and animal products

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ABSTRACT

Several studies have investigated the associations between personality traits and consumer behavior, but little attention has been paid to the role of personality traits in the acceptance of genetically modified (GM) food products or knowledge concerning the application of GM technologies. We used a large Norwegian survey to investigate the associations between personality traits, knowledge about GM use in agriculture, attitudes, and willingness to pay (WTP) to avoid GM foods. Using a random effect interval regression model, we found premiums between 19% and 23% to avoid GM soybean oil, GM-fed salmon, and GM salmon. Neuroticism was associated with increased acceptance of GM soybean oil. Conscientiousness was associated with increased acceptance of GM-fed and GM salmon, and agreeableness was associated with increased aversion against these products. Conscientiousness and agreeableness were also associated with knowledge. Agreeable respondents were less likely to think that genetic modification was applied in Norwegian agriculture, and conscientious respondents were more likely to wrongly think so. Attitudes towards naturalness of foods were strongly correlated with increased WTP to avoid GM foods. Current policy restrictions concerning the use of GM technologies are likely to affect the perceived safety of GM foods. Information and more liberal regulations may change attitudes towards GM foods and reduce the resistance against GM technologies over time.

1. Introduction

The potential risks and benefits of genetically modified (GM) foods have created concerns among consumers since the first GM food product was approved for human consumption in 1994. We focus on Norwegian consumer preferences as measured by willingness to pay (WTP) to avoid GM foods. The results in Bazzani, Gustavsen, Nayga, and Rickertsen (2018) indicate that Norwegian consumers are less willing to consume GM foods than U.S. consumers. However, Rickertsen, Gustavsen, and Nayga (2017) found that the average WTP to avoid GM soybean oil, GM-fed salmon, and GM salmon were similar and around 10% in both Norway and the U.S. This is substantially less than the premiums reported for these products about twenty years ago (Chern, Rickertsen, Tsuboi, & Fu, 2002).

Köster (2009) emphasized on taking psychological factors into account to understand the unconscious food related decision-making process. However, little attention has been paid to the effect of personality in the literature on WTP for GM foods. Personality may be defined as: 'relatively enduring patterns of thoughts, feelings, and behavior that reflect the tendency to respond in certain ways under certain circumstances' (Roberts, 2009: 140). We will investigate the role of personality using the Big Five personality traits (Goldberg, 1981). The five traits are openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (OCEAN), and these traits have successfully predicted behaviors across tasks and situations.[1] Personality traits are not absolutely fixed over the life cycle, but they change at different rates in different stages (Almlund, Duckworth, Heckman, & Kautz, 2011), and Cobb-Clark and Schurer, 2012 showed that personality traits are relatively stable among adults.

Knowledge is an important factor in consumer decision-making and information processing activities (Mitchell, 1982). Theories of preference formation and decision making indicate that when exposed to a product or receiving information from the environment, consumers create an overview of the situation before they form preferences

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[1] The Big Five personality traits are also known as the five-factor model or the OCEAN model. The traits have been able to explain and predict a variety of life outcomes including health status, educational achievements, and earnings (Mueller & Plug, 2006; Hampson, Goldberg, Vogt, & Dubanoski, 2007), risk and time preferences (Rustichini, DeYoung, Anderson, & Burks, 2012), and financial and investment decisions (Brown & Taylor, 2014). Almlund et al. (2011) provide a comprehensive review.

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(Jaeger, Wakeling, & MacFie, 2000). Knowledge about regulations on GM food products can affect consumers' attitudes, because adopted policies are viewed as decisions made by experts (Lusk, 2011). In Norway, no GM products are produced, sold, or used as feed (Mattilsynet, 2012). Using a field experiment, Pakseresht, McFadden, and Lagerkvist (2017) exposed individuals to different policy contexts and showed that restrictive policy scenarios induced the highest opposition against GM potato in Sweden.

This study has three objectives. The main objective is to investigate the effects of the OCEAN traits and knowledge about public policy on consumer preferences for GM foods. We estimate the WTP to avoid GM soybean oil (a plant-based GM food), GM-fed salmon (an animal that has been eating GM feed), and GM salmon (a GM animal). Second, we investigate the role of the OCEAN traits in having knowledge about current policy on the use of genetic engineering in agriculture. Finally, our products are identical to the products used in Rickertsen et al. (2017). However, we use a different and larger data set, and it is of interest to check the robustness of the results in their study.

2. Literature review

Personality has been associated with self-rated health and health outcomes, food choices, and taste preferences (e.g., Byrnes & Hayes, 2013; Chen, 2007; Gale, Batty, & Deary, 2008; Yangui, Costa-Font, & Gil, 2016). Several studies have investigated the effects of the OCEAN traits on food preferences. Goldberg and Strycker (2002) found that items constituting openness, conscientiousness, and agreeableness were associated with high consumption of fiber and avoidance of fat in food; Saliba, Wragg, and Richardson (2009) found that openness to experience was associated with a dislike of sweet taste in white wine; Knaapila et al. (2011) found that openness and extraversion were associated with seeking novel aspects in food and less food neophobia; Chang, Tseng, and Chu (2013) found that open, conscientious, and extrovert individuals cared more about food values, and had positive perception of food traceability labels; Keller and Siegrist (2015) found that openness and conscientiousness were associated with consumption of fruits and vegetables and restrained eating behavior, while neuroticism was associated with overeating and consumption of sweet and savory food; Grebitus and Dumortier (2016) found that agreeableness was associated with preference for organic tomatoes; Bazzani, Caputo, Nayga, and Canavari (2017) found that extraversion and agreeableness explained preference heterogeneity for local applesauce; Mora, Urdaneta, and Chaya (2019) found that extraversion, agreeableness, and conscientiousness were associated with positive emotional responses, and neuroticism was associated with negative emotional responses in wine tasting; and Gustavsen and Rickertsen (2019) found that high scores on extraversion and openness to experiences increased the frequency of wine consumption and high score on agreeableness reduced the frequency.

As far as we know, the only study that has investigated the effects of the OCEAN traits on WTP for GM foods is Lin, Ortega, Caputo, and Lusk (2019), who used a hypothetical choice experiment to investigate the effect of personality traits on the WTP for GM pork in the U.S., China, and Italy. They found that openness increased the valuation of GM pork and conscientiousness decreased the valuation in the U.S. and Italy. Agreeableness decreased and extraversion increased the valuation of GM pork among U.S. participants. Two studies have investigated the effects of the OCEAN traits on consumer preferences for labelling of GM foods. Peschel, Grebitus, Alemu, and Hughner (2019) used a hypothetical choice experiment and focused on GM-free, pesticide-free, and region of origin labelling of dates. Their results suggest that U.S. participants with high scores on openness, neuroticism, extraversion, and low scores on conscientiousness lost utility from dates labelled as GM-free only. DeLong and Grebitus (2018) used survey data and found that agreeable, conscientious, and extrovert participants wanted labelling of GM sugar and soft drinks with GM sugar contents, while open and neurotic individuals disagreed with GM labelling of these products.

OCEAN traits have also been associated with level of general knowledge, knowledge sharing, and knowledge seeking behaviors (Furnham & Chamorro-Premuzic, 2006; Matzler, Renzl, Müller, Herting, & Mooradian, 2008). Agreeableness and conscientiousness were associated with knowledge sharing, and conscientiousness was associated with knowledge acquisition (Gupta, 2008). Neuroticism and extraversion were negatively, and openness was positively correlated with general knowledge (Chamorro-Premuzic, Furnham, & Ackerman, 2006; Rolfhus & Ackerman, 1999). However, McEachern and Warnaby (2008) showed that openness to experience was negatively associated with knowledge about value-based labeled meats.

In the literature concerning GM foods, type of knowledge such as objective vs. subjective knowledge (e.g., House et al., 2004); knowledge about genetics (e.g., McFadden & Lusk, 2016); and product specific information such as risks and benefits of GM products (e.g., Lusk et al., 2004) have been studied. Several findings indicate that consumers' knowledge about GM foods is typically quite limited, and that GM-food aversion is mainly driven by subjective rather than objective knowledge (House et al., 2004; Huffman, Rousu, Shogren, & Tegene, 2007; Lusk et al., 2004). Wuepper, Wree, and Ardali (2018) asked four relatively basic questions to test German consumers' knowledge about GM foods. None of the 397 respondents answered all the questions correctly, and 36% did not answer any of them correctly. Results of a U.S. study with a broader set of questions suggest that peoples' beliefs have no solid scientific groundings, and 30–50% of the respondents had little or no knowledge about genetics (McFadden & Lusk, 2016).

In a *meta*-analysis of 57 WTP studies of GM foods conducted in several countries, Lusk, Jamal, Kurlander, Roucan, and Taulman (2005) found an average premium of 23% for conventional products. Compared with consumers in the U.S., European consumers indicated a 29% higher WTP for the conventional alternatives. In another *meta*-analysis, Frewer et al. (2013) found that public perceptions of benefits associated with GM food consumption had increased over time, but so had the perceptions about its risks resulting in consistent gaps in GM aversion between Europe and the U.S. They also found that GM technologies were more acceptable when applied to plants rather than animals. Recent results from several countries also indicate substantial positive WTP premiums to avoid GM foods. In a sample of U.S. students, 75% of the participants were on average willing to pay a 13% premium for non-GM items in restaurants (Lu & Gursoy, 2017). In a study including Belgium, France, the Netherlands, Spain, and the United Kingdom, participants were willing to pay 4 to 13 times more to avoid GM rice, with French consumers having the largest avoidance and Belgian consumers the lowest (Delwaide et al., 2015). In a sample of Russian consumers, only 20% of the participants were willing to purchase GM bread at a 50% discount as compared with conventional bread (Delmond, McCluskey, Yormirzoev, & Rogova, 2018).

3. Materials and methods

3.1. The survey

We used data from the Norwegian Monitory Survey (NMS). NMS is a nationally representative survey that has been conducted every second year since 1986 with 3,000–4,000 respondents in each round. It covers topics such as demographics, political and social preferences, ethical viewpoints, respondents' general values, food preferences, eating habits, health-related behaviors, and life-style choices (Ipsos-MMI, 2016). All the questions needed to construct the OCEAN traits were not included in NMS before 2015, and data for this year was used. The number of respondents was 3,981, and the respondents were assured that any given information was anonymous and that they could quit the survey whenever they wanted to.

Cobb-Clark and Schurer (2012) showed that although personality traits are not completely fixed, they are relatively stable among adults

Table 1
The Big Five personality traits.

Trait	APA definition [a]	Items [b]
Openness to experience	The tendency to be open to new aesthetic, cultural, or intellectual experiences	• Original with new ideas • Lively imagination • Likes to speculate and play with ideas • Few artistic interests
Conscientiousness	The tendency to be organized, responsible, and hardworking	• Do a thorough job • Careless • Usually have a messy life • Make plans and follow them up
Extraversion	An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience	• Talkative • Tends to be quiet • Shy • Outgoing and social
Agreeableness	The tendency to act in a cooperative, unselfish manner	• Helpful and selfless towards others • Can be cold and distance • Considerate and friendly to most of people • May sometimes be rude
Neuroticism	A chronic level of emotional instability and proneness to psychological distress	• Depressed • Relaxed, cope well with stress • Worries too much • Gets nervous easily

Source: Table 1 is adopted from Almlund et al. (2011).
Notes: [a] Definitions according to American Psychology Association's (APA) dictionary of psychology (APA, 2007). [b] Items are adjusted based on BFI-20 developed by Engvik and Clausen (2011).

aged 25 – 64 years, and we excluded respondents younger than 25 and older than 64 years old from the analysis. This excluded 1,721 respondents. Furthermore, we excluded 74 respondents due to missing values for the income variable, which left 2,186 respondents.

3.2. Measurement of variables

Consumers acceptance of GM foods was measured by the price premiums they were willing to pay to purchase the non-GM versions of each product. Respondents were asked to answer the following three questions: (i) "Imagine that you are purchasing soybean oil. The store has two types of oil. The first is made from non-genetically modified soy, and the other is made from genetically modified soy. How much more are you willing to pay for the non-genetically modified oil as compared with the genetically modified oil?". (ii) "Imagine that you are purchasing salmon. The store has two types of salmon. Non-genetically modified soy has been a part of the feed of the first type of salmon and genetically modified soy has been a part of the feed of the other type. How much more are you willing to pay for the salmon that has been fed non-genetically modified soy?". (iii) "Imagine a genetically modified salmon has been developed. The store has conventional farmed salmon and the genetically modified salmon. How much more are you willing to pay for conventional salmon?". The answer alternatives for each question were "nothing, will not pay more", "a maximum of 20% more", "21–50% more", "more than 50% more", and "do not know". We excluded 34 respondents with missing values for one or more of these alternatives, which left 2,152 respondents.

Knowledge was measured by the answers to the question: "Do you think genetic modification is used often, occasionally, rarely, or never in agriculture in Norway?". Respondents also had the 'do not know' alternative.

Personality traits were measured by a 20-item version of Big-Five Inventory (BFI-20), which was developed by Engvik and Clausen (2011). They constructed each trait on the basis of several items. Table 1 shows the five traits, their definitions according to American Psychology Association (APA) dictionary of psychology (American Psychological Association (APA), 2007), and the items associated with each trait. Each item was measured by self-reported scores on a scale from 1 (the item does not describe the respondent at all) to 7 (the item describes the respondent very well). BFI-20 was developed for situations where the time is limited, and it reached adequate levels of structural validity, factor divergence, maximal representation, test–retest reliability, and criterion validity (Engvik & Clausen, 2011).

We control for socioeconomic characteristics, general values associated with the environment and food's naturalness, and trust in food authorities. Such values and trust have been shown to be important for GM foods (e.g., Bredahl, 2001; Rickertsen et al., 2017; Traill et al., 2004). Value associated with environment was measured by the statement: "I am concerned with what I can personally do to protect the environment and natural resources", with answer alternatives given by a scale from 1 (totally agree) to 4 (totally disagree). We created a dummy variable, which was set to 1 if the individual totally or somewhat agreed with this statement, i.e., responded 1 or 2. Value associated with the naturalness of food was measured by the question: "When you are shopping food for your household or yourself, on which of the factors listed below do you put a great emphasize on?" Natural ingredients was one of the 25 factors listed, and multiple choices were allowed. We created a dummy variable set to 1 if natural ingredients was among one of the chosen items and zero otherwise. Trust in food authorities was measured by the answers to the question: "Here you can see logos of the three information offices for agricultural products. Which of the information offices do you think provides trustworthy and credible information?" Multiple choices were allowed, and we created a dummy variable set to 1 if at least one of the information offices was chosen and zero otherwise.

3.3. Construction of personality traits

The five personality traits were constructed in a two-step procedure. In the first step, we used confirmatory factor analysis (CFA) as implemented by the -sem- command in Stata/MP 15 (StataCorp, 2015). Following Jöreskog, Olsson, and Wallentin (2016: 283), we specified the general model:

$$x = \tau_x + \Lambda_x \xi + \delta \quad (1)$$

where $x = (x_1, \cdots, x_j)'$ is a vector of the observed items, $\tau_x = (\tau_{x1}, \cdots, \tau_{xj})'$ is a vector of constant terms, $\xi = (\xi_1, \cdots, \xi_p)'$ is a vector of the latent personality traits, and $\delta = (\delta_1, \cdots, \delta_j)'$ is a vector of error terms. The factor loadings in matrix Λ_x was constrained to be zero for items not associated with the specific personality trait. We assumed that

$\xi \sim N(0, \Phi)$ and $\delta \sim N(0, \Theta_\delta)$ are independently distributed, and the error covariance matrix Θ_δ is diagonal. The covariance matrix will be $\Sigma = \Lambda_x \Phi \Lambda_x^{'} + \Theta_\delta$ and it follows that $x \sim N(\tau_x, \Sigma)$. As is common, we let τ_x be unconstrained, and collected Λ_x, Φ, and Θ_δ into the parameter vector θ (Jöreskog et al., 2016: 286).

Maximum likelihood estimates of θ were found by minimizing the fit function with respect to θ:

$$F_{ML}(\theta) = \log|\Sigma| + \text{tr}(S\Sigma^{-1}) - \log|S| - J \quad (2)$$

where S is the sample covariance matrix, and J is the number of observed items. We used the Satorra and Bentler (1994) -vce(sbentler)- option in Stata/MP 15. This option provides robust standard errors and valid test statistics in the presence of non-normalities (StataCorp, 2015). The latent personality traits in the first step were predicted from the estimated model.

As discussed earlier, personality traits have been found to be relatively stable in the age range of our sample, but they may not be fixed over the life course. We followed a standard approach in the literature (e.g., Bucciol & Zarri, 2017), and implemented a second step to adjust for possible changes in the traits over the life course. In this step, we conditioned each of the predicted traits from the first step on a second-degree polynomial of age: $\widehat{\xi_p} = \alpha_{p1}(age) + \alpha_{p2}(age)^2 + \varepsilon_p$, standardized the resulting residuals, and used them as measures of personality traits in the subsequent analysis.[2]

3.4. Econometric models

We followed the specification in Rickertsen et al. (2017), and estimated WTP premiums and the associated marginal effects of the explanatory variables. WTP premiums were available in the intervals described above, and an interval regression model was used. The interval regression model is a generalization of the Tobit model with known intervals (Amemiya, 1973).

For each respondent, we have three WTP premiums, one for each product, and this panel structure was taken into account. We applied a random effects interval regression model, in which individual characteristics that are constant across products were treated as random parameters. Each respondent's WTP premium was specified as:

$$WTP_{ig} = G_1 Z'_i \beta_1 + G_2 Z'_i \beta_2 + G_3 Z'_i \beta_3 + v_i + e_{ig} \quad (3)$$

where the subscript $i = 1, \ldots, n$, denotes respondents and the subscript $g = 1, 2, 3$ denotes products. G_1, G_2,and G_3 are dummy variables, and each dummy variable took the value of one for the relevant product (GM soybean oil, GM-fed salmon, or GM salmon). Z'_i is the vector of the explanatory variables containing the age-adjusted predicted personality traits, knowledge, and control variables, and β_1, β_2, β_3 are parameter vectors associated with the explanatory variables for GM product g. The error term v_i represents respondent-specific random variation that was assumed to be iid $N \sim (0, \sigma_v^2)$.This variation was assumed to be constant across the products for one respondent. The error term e_{ig} is an observation-specific error term that represents all other unobserved factors affecting the WTP, and it was assumed to be independent of v_i and $N \sim (0, \sigma_e^2)$. The proportion of the total variance contributed by the panel-level variance component is $\rho = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_e^2}$, where $\sigma_v^2 = \text{Var}(v_i)$ and $\sigma_e^2 = \text{Var}(e_{ig})$. When this proportion is high, the respondent-specific variation is high, the panel structure is important, and the pooled estimator will give incorrect standard errors (StataCorp, 2015). We used the -xtintreg- procedure in Stata/MP 15 to estimate this model (StataCorp, 2015).

We estimated a probit model to investigate the effects of personality traits on the probability of having incorrect knowledge concerning the use of genetic modification, i.e., thinking that genetic modification is applied often, occasionally, or rarely in Norwegian agriculture. The observed binary outcome variable was defined as:

$$y_i = \begin{cases} 1, & \text{if} \quad y^* = Z'\gamma > 0 \\ 0, & \text{otherwise} \end{cases} \quad (4)$$

where y^* is the continuous latent lack of knowledge variable, Z' is the vector of all explanatory variables used in Eq. (3) except for knowledge, and γ is the vector of parameters. The probability of lack of knowledge given the explanatory variables is $p(y = 1|Z) = \Phi(Z'\gamma)$ where Φ () is the standard normal cumulative distribution function.

4. Results

4.1. Descriptive analysis

The distributions of the WTP premiums to avoid GM alternatives for 2,152 respondents are shown in Table 2. Between 20 and 25% of the respondents indicated that they would pay nothing to avoid the GM alternatives, around 32% indicated that they would pay up to 20% more, 14–18% were willing to pay 20–50% more, and 11–15% indicated that they were willing to pay more than 50% more. Around 15–20% of the respondents chose the 'do not know' option. These respondents were not always the same for all the alternatives, and we excluded 557 respondents who answered 'do not know' for at least one alternative, which left 1,595 respondents.

Table 3 provides the percentage distribution of the answers to the knowledge question. Only 30% answered correctly, i.e., never. Approximately 56% answered wrong, 10% did not know, and the rest did not answer the question. We aggregated the responses and created a dummy variable set to 1 if the respondent answered this question incorrectly; often, occasionally, or rarely and zero otherwise (including do not know and missing value).

The mean values and standard deviations of the 20 items used to construct the OCEAN traits are shown in Table 4 (columns 2 and 3). Estimation results of the CFA and some measures related to the validity of the constructed traits are shown in the five last columns of Table 4. The scores on some of the items are reversed, for example, a respondent who scored high on the item (non) unaesthetic is very aesthetic. It was recorded a missing value for 108 respondents on one or more of the 20 items. The summary statistics reported in Table 4 are based on 1,487 respondents with no missing value for any of the 20 items. However, personality traits can be constructed also for these respondents as long as there is at least one non-missing value among the items for each trait, and the number respondents in the subsequent analysis is 1,595.

In column 2, the mean scores for items associated with agreeableness were highest (5.1 to 6.0), and they were lowest for items associated with neuroticism (2.4 to 3.6). Columns 4 and 5 show the standardized factor loadings and their Satorra-Bentler robust standard errors, respectively. According to Hair, Black, Babin, Anderson, and Tatham (2014: 618), these factor loadings should be above |0.5|, which is the case with the exception of five items. Columns 6–8 show the average variance extracted (AVE), Cronbach's alpha values (Alpha), and the construct reliability (CR) for each of the five traits. According to the critical values of these measures provided in Hair et al. (2014: 619), eight out of 15 measures indicate a high degree of accuracy of the constructed traits, and most of the inaccuracies are related to the AVE values. To be consistent with BFI-20, we retained all the items in the constructed traits.

Fig. 1 shows the distribution of the predicted personality traits from the first step (unadjusted for age), with their means and standard deviations. The mean values were always close to zero. However, the distribution of openness to experience, extraversion, and neuroticism were much wider than the distributions for conscientiousness and agreeableness.

[2] The results of our model, did not change substantially when the traits, as constructed in the first step, were used in the analysis. Further results are available upon request.

Table 2
Willingness to pay to avoid GM alternatives, percentage distributions.

Premium	GM soybean oil	GM-fed salmon	GM salmon
Nothing	21.0	24.6	20.0
Max. of 20% more	31.5	32.0	31.1
21–50% more	13.7	14.1	18.0
More than 50% more	14.0	11.1	15.4
Do not know	19.8	18.3	15.5

Note: Based on 2,152 respondents aged 25 to 64 years.

Table 3
Knowledge concerning the use of GM technologies in Norwegian agriculture, percentage distribution.

Frequency	Percent
Often	6.0
Occasionally	22.8
Rarely	27.2
Never	29.9
Do not know	9.9
Missing value	4.5

Note: Based on 1,595 respondents aged 25 to 64 years.

Table 5 provides the summary statistics of the explanatory variables for all the respondents (total; $n = 1{,}595$), for respondents who had a WTP = 0 for at least one of the GM-free alternatives (accepters; $n = 501$), and for respondents who had a WTP greater than 0 for all the GM-free alternatives (avoiders; $n = 1{,}094$). The last column of the table reports results of a *t*-test for equality of the mean values between avoiders and accepters. Accepters of GM products were on average less conscientious, less extrovert, and less agreeable than avoiders. In the total sample, the average age was 46 years, 48% were male, 70% had completed a bachelor's degree, 41% had children aged 15 years or less in the household, and 51% had grandparents who own or had owned a farm. About 75% of the total sample considered at least one of the information offices for agricultural products (dairy, fruits and vegetables, or meat) to be a trustworthy source of information, 58% were concerned with protecting the environment, and 62% claimed to put great emphasize on natural ingredients while shopping food.

The correlation matrix between the age-adjusted personality traits are presented in Table 6. The correlations printed in bold are significantly different from zero at the 5% level of significance. Even though several of the correlations were significantly different from zero, none were above 0.64.

4.2. Willingness to pay

Table 7 provides the parameter estimates and standard errors of the WTP and probit models with and without personality traits. Likelihood-ratio tests rejected no effects of personality traits in both models (*p*-values < 0.02), and we discuss the results of the models with personality traits.[3] In the WTP model, the contribution of the panel level variance to overall variance was high (0.91). The estimated marginal effects of the socioeconomic and attitudinal variables were similar in the models with and without personality traits, which correspond well with the results in Grebitus and Dumortier (2016), who found that adding personality traits did not substantially alter the effect of values on demand for organic products.

The estimated parameters of the WTP model represent the marginal WTP premiums to avoid the GM alternatives. The alternative specific constants represent the WTP to avoid the associated GM alternatives for a non-existent reference respondent, i.e., a female with zero age, zero income, etc. Most of the socioeconomic variables were insignificant. For GM salmon, a one-year increase in age decreased the WTP by 0.08%, and 1% increase in income increased the WTP by 1%.

Naturalness and trust were important for the WTP premiums. The effects were particularly large for naturalness. Respondents who found naturalness important, were willing to pay more than 15% more for the conventional alternatives. Trust in the information offices in agriculture reduced the WTP premium to avoid GM soybean oil and GM salmon by about 1.7%. Knowledge also had significant but moderate effects on the WTP, the premiums were 2–3% lower among respondents who thought that genetic modification is already being applied in Norwegian agriculture than among other respondents.

Conscientiousness, agreeableness, and neuroticism were associated with WTP to avoid the GM alternatives. WTP to avoid GM-fed and GM salmon decreased by around 1.2% as conscientiousness increased by one standard deviation, and increased by almost 0.9% as agreeableness increased by one standard deviation. WTP to avoid GM soybean oil decreased by 0.7% as neuroticism increased by one standard deviation. Fig. 2 illustrates the significant relationships. The horizontal axes represent the scores of the personality traits, and the vertical axes show the average predicted WTP premiums that respondents were willing to pay to avoid the corresponding GM alternative. The two top panels show the effects of conscientiousness, the two middle panels show the effects of agreeableness, and the bottom panel shows the effect of neuroticism. The dotted lines give 95% confidence intervals for the point estimates. Fig. 2 indicates that increased scores of conscientiousness and neuroticism decreased GM aversion, whereas increased scores of agreeableness increased the aversion.

We bootstrapped the sample using 300 repetitions, predicted the WTP for each sample, and calculated the average premiums to avoid each GM alternative. The estimated percentage premiums and the associated standard errors are presented in Table 8. The premiums to avoid GM soybean oil was 21%, to avoid GM-fed salmon was about 19%, and to avoid GM salmon was almost 23%. The total effects of personality traits on WTP premiums are relatively small.

4.3. Knowledge of the use of GM technologies

A positive sign of an estimated parameter of the probit models in Table 7 indicates an increased probability of not knowing the current restriction on the use of GM technologies in Norwegian agriculture. Rather than discussing the parameter estimates, we describe the average marginal effects (AMEs), i.e., the average change in probability when the associated variable increases by one unit.

In the model with personality traits, the pseudo R-squared value was low (0.03), however, there were some statistically significant AMEs. A one-year increase in age decreased the probability of incorrectly thinking that GM technologies are in use by 0.5%, and having grandparents who own or have owned a farm reduced this probability by 9%. Rather surprisingly education does not have an effect. The AMEs indicate that a one standard deviation increase in conscientiousness increased the probability of having incorrect knowledge by 4%, and a one standard deviation increase in agreeableness decreased the probability of the incorrect knowledge by 6%. Fig. 3 illustrates these significant relationships. The horizontal axes show scores of conscientiousness and agreeableness, and vertical axis show the average predicted probability

[3] We did several other specification tests. First, we tested a WTP model with identical marginal effects and alternative-specific constants (ASC) for the three GM foods. This model was rejected (*p*-value = 0.00). We also tested WTP models with only socioeconomic variables or personality traits, and these models were rejected (*p*-values = 0.00). Second, we tested the probit model against a model excluding attitudes, and this model was not rejected (*p*-value = 0.43). We also tested a probit model with only personality traits, and this model was rejected (*p*-value = 0.00). To be consistent with the specification of the WTP model, we report the results of the full probit model. More estimation results can be provided upon request.

Table 4
Summary statistics of the items used to construct the OCEAN traits.[a]

Item	Mean	Std. dev.	Std. factor loadings [b]	SB std. err. [c]	AVE [d] (%)	Alpha [e]	CR [f]
Openness to experience					39	0.66 (0.63)	0.70
Original	4.16	1.48	0.73	0.02			
Imaginative	4.33	1.68	0.65	0.02			
Ideas	4.38	1.59	0.70	0.02			
(non) Unaesthetic [g]	4.41	2.00	0.32	0.03			
Conscientiousness					27	0.54 (0.57)	0.59
Thorough	5.82	1.06	0.45	0.03			
(non) Careless [g]	4.70	1.59	0.38	0.03			
(non) Messy [g]	5.59	1.50	0.65	0.03			
Discipline	5.00	1.35	0.55	0.03			
Extraversion					53	0.80 (0.78)	0.82
Talkative	4.49	1.62	0.71	0.02			
(non) Quiet [g]	4.46	1.73	0.76	0.02			
(non) Shy [g]	5.23	1.62	0.64	0.02			
Social	4.93	1.52	0.80	0.02			
Agreeableness					27	0.58 (0.63)	0.60
Helpful	5.33	1.23	0.44	0.03			
(non) Cold [g]	5.36	1.51	0.65	0.03			
Friendly	6.03	1.02	0.50	0.03			
(non) Rude [g]	5.10	1.60	0.48	0.03			
Neuroticism					45	0.74 (0.73)	0.77
Depressed	2.38	1.49	0.67	0.02			
(non) Relaxed [g]	3.27	1.57	0.56	0.02			
Worried	3.64	1.80	0.75	0.02			
Nervous	3.02	1.65	0.70	0.02			
SB-RMSEA[h]			0.08				

Notes: [a] Based on 1,487 respondents aged 25 to 64 years. [b] Standardized factor loadings from performing a confirmatory factor analysis (CFA) using the -sem-command in Stata/MP 15. All the loadings are significant at the 1% level. [c] Satorra-Bentler (SB) robust standard errors, using the -vce(sbentler)- option (Satorra & Bentler, 1994). [d]Average variance extracted (AVE) is variance extracted for the items loading on a construct, calculated as: $AVE = \frac{\sum_{i=1}^{k} L_i^2}{n}$, where L_i refers to standardized factor loadings and n to number of loadings on each trait. $AVE > 50\%$ suggests adequate convergence (Hair et al., 2014: 619). [e] Cronbach's alpha values are scale reliability coefficients for the standardized items. Values above 0.6 suggest construct reliability (Hair et al., 2014: 619). Values in parentheses are Cronbach's alpha values from the developers of BFI-20 (Engvik & Clausen, 2011). [f] Construct reliability (CR) is calculated as $CR = \frac{(\sum_{i=1}^{k} L_i)^2}{(\sum_{i=1}^{k} L_i)^2 + (\sum_{i=1}^{k} e_i)^2}$., where e_i refers to error variances. Values above 0.6 suggest reliability (Hair et al., 2014: 619). [g] The score of the item is reversed. [h] Satorra-Bentler (SB) robust root mean squared error of approximation (RMSEA). Values about 0.08 or less suggest a reasonable approximation, and above 0.1 suggest a poor fit (Browne & Cudeck, 1993: 144).

of the incorrect knowledge, and the dotted lines show the 95% confidence intervals for the point estimates. The figure illustrates how increased scores of conscientiousness increased the probability of the incorrect knowledge, while increased scores of agreeableness reduced the same probability.

5. Discussion, implications, and limitations

Our estimated WTP premiums to avoid GM alternatives were between 19 and 23%. These premiums correspond well with the results of the meta-analysis of Lusk et al. (2005), who found an average premium of 23% to avoid GM foods, but they are about twice as high as the premiums reported for the Norwegian respondents in Rickertsen et al. (2017). This difference can be due to differences in the socioeconomic characteristics of the participants in the two samples (e.g., age distribution), survey format (paper versus on-line), and other factors.

In line with the results in McFadden and Lusk (2016) and Wuepper, Wree, and Ardali (2018), we find that respondents were not very knowledgeable about GM-related issues, and around 56% of our sample thought GM technology was applied in Norwegian agriculture.

The lowest aversion was towards a GM-fed animal and the highest against a GM animal. In studies that have compared consumer attitude towards plant based GM foods, GM-fed animals, and GM animals, a corresponding pattern has been observed (Chern et al., 2002; Rickertsen et al., 2017). One explanation could be that consumers become less averse when genetic modification is not directly applied to the final product that he/she consumes. Therefore, GM-fed animal products might be more accepted in the market than GM plant and animal products for human consumption.

Respondents who found natural ingredients to be important indicated much higher premiums to avoid all GM products, which suggests that consumers perceive conventional products more natural than their GM counterparts. This is in line with previous studies, which found perceived lack of naturalness to be an important barrier towards acceptance of GM foods (Rickertsen et al., 2017; Siegrist, 2008). Concerns about unnaturalness of GM foods could change quite rapidly given increased familiarity with these products and information about the similarities between GM techniques and conventional breeding. Similar to the results in Hossain and Onyango (2004) and Siegrist (2000; 2008), our results indicate that trust in food authorities reduced GM aversion. Current strict policy restrictions concerning the use of genetic modification may give the impression that GM foods are less safe. Given a high degree of trust in public authorities, this impression may result in reduced acceptance of GM foods. Finally, as Lusk (2011) and Pakseresht et al. (2017), we find that respondents who did not know that application of genetic modification is prohibited in Norwegian agriculture were less GM averse.

Our results indicate that personality traits are a source of heterogeneity in attitudes towards GM foods, and knowledge about application of genetic modification. Conscientiousness was associated with GM acceptance. This effect is opposite of Lin et al. (2019), who found that conscientious individuals had lower WTP for GM pork in the U.S. and Italy. One possible explanation is that conscientious individuals are thorough and achievement oriented. They may be more likely to base their attitudes on scientific results, which claims no additional risks of consumption of approved GM foods (WHO, 2014). However, when it comes to the knowledge about current use of genetic modification in Norway, our results do not indicate higher knowledge level among conscientious respondents.

Agreeableness was associated with GM aversion. This result

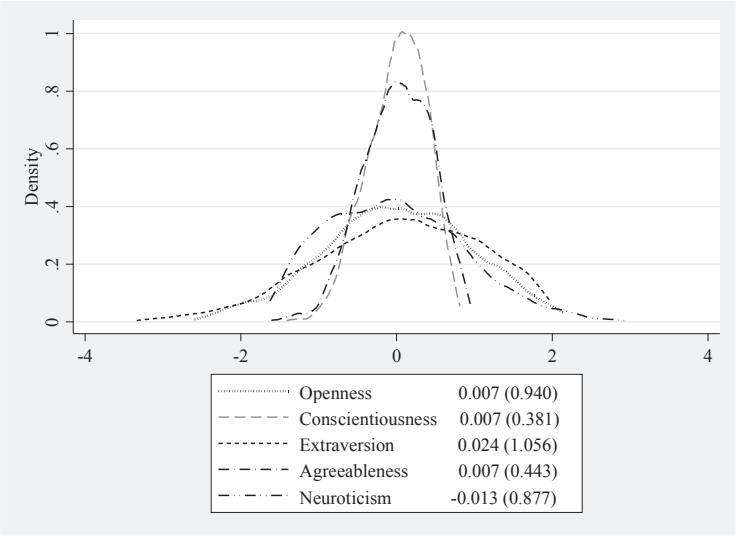

Fig. 1. Distribution of Big Five personality traits – predicted values.
Notes: Based on 1,595 respondents aged 25 to 64 years. Predicted values for latent personality traits from the first step of the CFA (unadjusted for age). Means with standard deviations in parentheses.

Table 5
Summary statistics of the explanatory variables.[a]

Variable	Description	Mean total	Mean accepters [b]	Mean avoiders [c]	T-value [d]
Age	Age in years	46.16 (10.82)	46.18	46.16	−0.03
Income [e]	Log of households' income	6.66 (0.56)	6.56	6.71	**5.06**
Gender	= 1 if male	0.48 (0.50)	0.59	0.42	**−6.33**
Education	= 1 if bachelor or more	0.70 (0.46)	0.63	0.72	**3.69**
Children	= 1 if have children under 15 years old	0.41 (0.49)	0.35	0.43	**2.99**
Farm	= 1 if grandparents have (ever) had a farm	0.51 (0.50)	0.45	0.54	**3.14**
Environment	= 1 if somewhat/ totally concerned with environment	0.58 (0.49)	0.50	0.62	**4.38**
Naturalness	= 1 if natural ingredients matter while shopping	0.62 (0.49)	0.49	0.68	**7.42**
Trust	= 1 if trust in at least one of the food information offices	0.75 (0.44)	0.75	0.75	0.01
Openness[f]	Standardized residuals	0	0.01	−0.00	−0.20
Conscientiousness[f]	Standardized residuals	0	−0.09	0.04	**2.44**
Extraversion[f]	Standardized residuals	0	−0.08	0.04	**2.17**
Agreeableness[f]	Standardized residuals	0	−0.11	0.05	**3.00**
Neuroticism[f]	Standardized residuals	0	−0.00	0.00	0.05
n		1,595	501	1,094	

[a] Standard deviations in parentheses.
[b] Respondents who had a WTP = 0 for at least one of the alternatives.
[c] Respondents who had a WTP greater than 0 for all the three alternatives.
[d] Results of a *t*-test on the equality of the means between avoiders and accepters of GM foods. Bold print indicates significance at the 5% level.
[e] Income in NOK was divided in eleven income groups. We set the respondents' income to the midpoint of the income group. For the highest and lowest income, the censoring point was set as the income.
[f] The traits are standardized net traits.

Table 6
Correlation matrix of personality traits' after correcting for age.

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Openness	1.00				
Conscientiousness	**−0.17**	1.00			
Extraversion	**0.19**	**0.28**	1.00		
Agreeableness	−0.03	**0.64**	**0.57**	1.00	
Neuroticism	−0.01	**−0.39**	**−0.47**	**−0.43**	1.00

Notes: Based on 1,595 respondents aged 25 to 64 years. The traits are standardized net traits and bold print indicates significance at the 5% level.

Table 7
Parameter estimates with standard errors in the parentheses [a].

	GM soybean oil		GM-fed salmon		GM salmon		Knowledge GM	
	No traits[b]	Traits[c]	No traits[b]	Traits[c]	No traits[b]	Traits[c]	No traits[d]	Traits[e]
Constant	**11.15** (2.91)	**12.20** (2.93)	**13.57** (2.88)	**13.20** (2.91)	**12.49** (2.85)	**11.38** (2.89)	0.19 (0.41)	0.34 (0.42)
Age	0.01 (0.02)	0.01 (0.02)	0.01 (0.02)	0.01 (0.02)	**−0.08** (0.02)	**−0.08** (0.02)	**−0.01** (0.00)	**−0.01** (0.00)
Income	−0.02 (0.44)	−0.15 (0.45)	−0.41 (0.43)	−0.33 (0.44)	0.77 (0.43)	**1.00** (0.45)	0.10 (0.06)	0.08 (0.06)
Gender	0.17 (0.53)	−0.26 (0.55)	−0.58 (0.52)	−0.88 (0.55)	−0.12 (0.52)	−0.63 (0.55)	−0.02 (0.07)	−0.05 (0.07)
Education	0.53 (0.58)	0.61 (0.58)	−0.64 (0.57)	−0.58 (0.57)	0.37 (0.57)	0.34 (0.57)	0.11 (0.07)	0.09 (0.07)
Children	0.57 (0.56)	0.41 (0.56)	−0.40 (0.56)	−0.58 (0.56)	−0.69 (0.55)	−0.84 (0.56)	**−0.15** (0.07)	−0.13 (0.07)
Farm	1.00 (0.51)	0.87 (0.51)	0.33 (0.51)	0.14 (0.51)	0.43 (0.51)	0.26 (0.50)	**−0.25** (0.06)	**−0.24** (0.06)
Environment	0.85 (0.52)	**1.22** (0.54)	0.26 (0.52)	0.50 (0.53)	0.70 (0.52)	0.84 (0.53)	−0.02 (0.07)	−0.02 (0.07)
Naturalness	**16.34** (0.55)	**16.21** (0.54)	**15.52** (0.54)	**15.38** (0.54)	**16.75** (0.54)	**16.55** (0.53)	0.13 (0.07)	0.11 (0.07)
Trust	**−1.74** (0.57)	**−1.70** (0.57)	−1.04 (0.57)	−1.04 (0.56)	**−1.72** (0.57)	**−1.65** (0.57)	0.00 (0.07)	0.01 (0.07)
Knowledge	**−2.88** (0.54)	**−3.01** (0.52)	**−1.95** (0.52)	**−1.97** (0.51)	**−2.70** (0.54)	**−2.76** (0.52)		
Openness[f]		−0.18 (0.25)		−0.05 (0.25)		0.39 (0.25)		0.07 (0.03)
Conscientiousness[f]		−0.48 (0.34)		**−1.08** (0.34)		**−1.18** (0.33)		**0.11** (0.04)
Extraversion[f]		0.08 (0.32)		−0.43 (0.32)		−0.60 (0.32)		0.05 (0.04)
Agreeableness[f]		−0.30 (0.36)		**0.84** (0.36)		**0.83** (0.35)		**−0.15** (0.05)
Neuroticism[f]		**−0.69** (0.31)		−0.42 (0.31)		−0.39 (0.30)		−0.02 (0.04)
n	4,785[g]	4,785[g]					1,595	1,595
Loglikelihood	−7,962	−7,947						
Pseudo R^2							0.02	0.03
AIC	15,995	15,994					2,166	2,162
BIC	16,222	16,318					2,220	2,243
LR-test		0.01						0.02
ρ	0.91	0.91						

[a] Bold print indicates significance at the 5% level.
[b] Random effect interval regression model without personality traits.
[c] Random effect interval regression model with personality traits.
[d] Probit model without personality traits.
[e] Probit model with personality traits.
[f] The traits are standardized net traits.
[g] Balanced panel with three observations per respondent.

corresponds well with DeLong and Grebitus (2018), who found agreeableness to be associated with a desire for labelling of GM food and ingredients (DeLong & Grebitus, 2018). Our effect of agreeableness is also consistent with the effect in Lin et al. (2019), who reported a negative association between agreeableness and valuation of GM pork among U.S. consumers. Moreover, agreeableness increased the probability of having correct knowledge. Given the higher GM aversion among those who were aware of the restrictions on the application of genetic modification in Norway, agreeable respondents may be GM averse because they mirror the attitudes of the rest of the society, including the attitudes reflected in public policies. If the environment changes in favor of GM food, it seems plausible that agreeable respondents would be less averse towards GM foods given how their personality contributes to their attitude formation.

Neuroticism was associated with acceptance of GM soybean oil only. This result is consistent with DeLong and Grebitus (2018), who found that consumers with higher scores on neuroticism disagreed with labeling the sugar in soft drinks when it was produced with GM seeds. Peschel et al. (2019) also found that neurotic consumers lost utility from dates labeled as GM-free.

Our results suggest that the acceptance of GM foods is associated with attitudes towards naturalness, trust in public authorities, knowledge, and personality traits. While the personality traits are relatively constant, attitudes towards naturalness are likely to be more fungible and could more easily be changed over time by information about that there is nothing inherently more unnatural about GM foods than conventional foods. Furthermore, given the importance of trust in public authorities, more liberal regulations on the use of GM technologies in agriculture and sales of GM foods could also increase the acceptance. The last conclusion is supported by the higher GM acceptance among those who thought genetic modification was applied in Norwegian agriculture.

There are four main limitations in this study that could be further investigated. First, we used a 20-item version of the Big-Five Inventory. A more complete version based on more items would give a more nuanced measurement of personality and could potentially modify the results. However, it would be difficult to implement in a large survey with a topically wide coverage and many other questions. Second, our survey did not include real economic incentives, and the results may suffer from a hypothetical bias. A meta-analysis of the hypothetical bias problem is provided by, for example, List and Gallet (2001). Third, our measures of attitudes towards naturalness, trust, and environment are based on some questions that may be further developed to test the robustness of our conclusions regarding the effects of attitudes on acceptance. Finally, we did not differentiate between objective and subjective knowledge, which is an interesting issue.

6. Conclusions

We have estimated the effects of socioeconomic variables, attitudes, knowledge, and personality traits on the WTP to avoid GM soybean oil, GM-fed salmon, and GM salmon. We found few significant marginal effects of socioeconomic variables, some effects of knowledge and trust, and strong effects of attitudes towards naturalness. Respondents who found naturalness to be important were willing to pay more than 15% additional premiums for the conventional alternatives.

Even though the average premiums did not change substantially when personality traits were excluded, there were several significant effects of these traits on the WTP premiums for GM soybean oil, GM-fed salmon, and GM salmon. Personality traits were also associated with

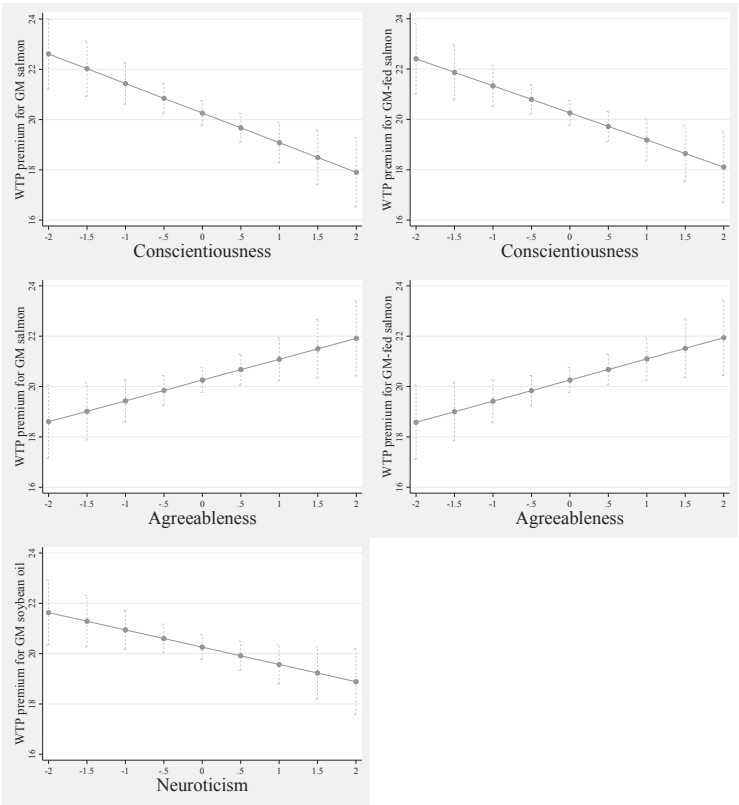

Fig. 2. Marginal effects of personality traits on WTP for GM and GM-fed salmon.
Notes: Based on 1,595 respondents aged 25 to 64 years. The traits are standardized net traits. The observed values of other variables were used in Fig. 2.

Table 8
Estimated WTP to avoid GM alternatives, percentage premiums.

WTP	GM soybean oil	GM-fed salmon	GM salmon
Without personality traits	20.63 (0.98)	18.92 (0.92)	22.33 (1.09)
With personality traits	21.00 (1.07)	19.26 (0.99)	22.78 (1.20)

Notes: Based on 1,595 respondents aged 25 to 64 years. Estimated by the -predict- command after the interval regression analysis in Stata/MP 15.1. Bootstrapped standard errors based on 300 repetitions are given in the parentheses.

knowledge concerning the use of GM technologies in Norwegian agriculture. These associations suggest that personality traits are correlated with some of the heterogeneity among respondents, and this source of heterogeneity needs to be further studied.

Our results are useful for policy makers, campaigners, and others interested in GM foods. We found moderate effects of stable personality traits and strong effect of attitudes towards naturalness. Information and changes in regulations, which are based on solid scientific evidence and emphasize that there is nothing inherently more unnatural about GM foods than conventional products, are likely to increase the acceptance of GM foods over time.

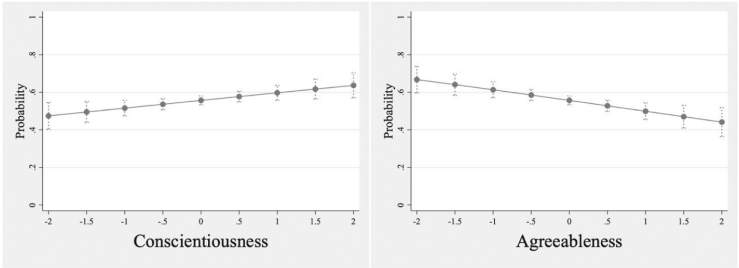

Fig. 3. Marginal effects of personality traits on knowledge.
Notes: Based on 1,595 respondents aged 25 to 64 years. The traits are standardized net traits. The observed values of other variables were used in Fig. 3.

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Appendix A. Supplementary data

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Paper III

Food values, personality traits and attitudes towards genetically modified food

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Abstract

We explored the effects of personality traits and subjective beliefs for determining the willingness to pay (WTP) to avoid genetically modified (GM) food products. The personality traits were measured by the Big Five model, and the subjective beliefs were measured as preferences over a set of food values. We used data from an online survey conducted in Norway and the US. The effects of sociodemographic factors and personality traits on WTP values are country-specific, while the effects of food values are more homogenous across the two countries. Our findings suggest that GM aversion is the result of believing that GM products are unnatural with possible negative impacts on the environment and animal welfare, and also unfair to farmers, processors, and retailers. Respondents also believed that GM foods are not locally produced, do not have an appealing appearance, and lack convenience. Our findings are potentially useful to regulate applications of GM technologies as well as to develop international strategies for promoting new GM foods.

Keywords: Big Five, beliefs, consumer preferences, food values, genetic modification.

1. Introduction

The concerns about genetically modified (GM) foods are frequently associated with risk perceptions that are not based on scientific results. Nevertheless, there is no agreement on why such concerns have persisted for so long towards a technology that is considered to be as safe as conventional methods (Economidis, Cichocka, and Hoegel, 2010; WHO, 2014). Lusk, Roosen, and Bieberstein (2014) pointed out that the literature has focused more on measuring individuals' preferences or valuations of GM foods than on measuring beliefs, while findings suggest that individuals' a priori beliefs are among the most important determinants of attitudes towards GM foods (Lusk et al., 2004; Dixon, 2016).

Beliefs may be reflected by food values, which refer to a set of food specific meta preferences that are based on overall life values and were developed by Lusk and Briggeman (2009). They suggested a set of 11 food values that could be relatively stable over time and explain consumers' food choices across a wide range of food products. These values are naturalness, taste, price, safety, convenience, nutrition, tradition, origin, fairness, appearance, and environmental impacts. Lusk and Briggeman's (2009) suggested list were based on a review of the literature in consumers' attitudes towards food and in particular studies based on means-end chain model (Gutman, 1982). According to the means-end chain model, consumers' attitudes towards product attributes are connected to individuals' personal values. Lusk and Briggeman (2009) explain that these food values correspond with some of the dimensions of Schwartz' (1992) value taxonomy such as benevolence, hedonism, security, and stimulation. The relative importance of food values has been found to be relatively stable over time (Tonsor, Lusk, and Schroeder, 2018), and to represent a more permanent component of individual preferences for food (Lusk, 2011b; Lusk and Briggeman, 2009). Lusk (2011b) and Pappalardo and Lusk (2016) showed that the relationship between these food values and attitudes towards a specific food product also revealed the subjective beliefs about this product.

Accounting for individuals' characteristics such as psychological factors may improve the understanding of preference heterogeneity in general and choice patterns for foods in particular (e.g., Bazzani et al., 2017; Köster, 2003). The Big Five personality traits (Goldberg, 1981) is one of the most frequently used models to measure and classify personality traits into five broad dimensions: openness to experiences, conscientiousness, extraversion, agreeableness, neuroticism (OCEAN). The OCEAN traits have been found to represent individuals' enduring coherence of behaviors, which are relatively stable over time (e.g., Cobb-Clark and Schurer, 2012; Conely, 1984).

Attitudes may be reflected by the willingness to pay (WTP). As far as we know, two studies have investigated the effects of the OCEAN traits on WTP for GM foods (Ardebili and Rickertsen, 2020; Lin et al., 2019), and the effects of food values on the WTP for GM foods have not been investigated. Our objective is to investigate the associations between WTP for GM foods and food values and personality traits in Norway and the US. The data were collected by an online survey in Norway and the US conducted in 2015, and we consider

three GM alternatives; GM soybean oil (a plant-based GM food), GM fed salmon (animal fed with GM food), and GM salmon (GM animal). The data have been used to estimate the WTP to avoid GM foods in Rickertsen, Gustavsen, and Nayga (2017). However, they did not investigate the effects of the OCEAN traits or food values. The data have also been used in Bazzani et al. (2018) to compare the relative importance of food values in Norway and the US and in Ardebili and Rickertsen (2021) to investigate the associations between food values and personality traits. Neither Bazzani et al. (2018) nor Ardebili and Rickertsen (2021) investigated WTP to avoid GM foods.

2. Literature Review

The literature related to relevant topics for this paper is huge, and we will not try to provide a full review. We will focus on recent studies related to food values and their effects on consumer preferences and demand for food, the OCEAN traits and preferences for food in general and more specifically GM foods, the effects of knowledge and beliefs on GM aversion, and WTP for GM foods.

2.1. Food values

Using the same data set as this study, Bazzani et al. (2018) compared the relative importance of food values in the US and Norway. They found that food safety was most important in both countries, which is in line with the results reported in Lusk and Briggeman (2009) for the US. Bazzani et al. (2018) also found that the price was ranked quite differently in the two countries; price was ranked as the second most important value in the US and only the sixth most important in Norway.

Food values are also associated with preferences and demand for food. Lusk and Briggeman (2009) found that price was negatively associated with higher WTP for organic bread, while nutrition, naturalness, environmental impact, and origin were positively associated. Lusk (2011b) used household scanner data to predict the demand for organic food. He found that environmental impact and tradition were associated with higher demand for organic eggs and milk, while price and convenience were associated with lower demand. Tonsor, Lusk, and Schroeder (2018) used US survey data and found that animal welfare,

nutrition, environment, and naturalness were negatively associated with the demand for beef steak and ground beef. Taste, appearance, and novelty were positively associated while safety was unimportant for both products. Finally, in an Italian experimental auction for functional food, Pappalardo and Lusk (2016) found that the WTP for functional foods was positively associated with food value health. However, after tasting the snack, safety and taste were associated with lower WTP. These results indicate that individuals may believe that functional foods are healthy but not as tasty and safe as the conventional products.

2.2. OCEAN traits

Many recent studies have found that the OCEAN traits are associated with food choices, and food-related attitudes or preferences. Gustavsen and Hegnes (2020a; 2020b) found that openness to experience was positively related to the attitudes towards organic food and local food; Ufer, Lin, and Ortega (2019) found that extraversion and conscientiousness increased preferences for cooperative-grown coffee; Gustavsen and Rickertsen (2019) found that agreeableness was negatively, and extraversion and openness to experience were positively associated with consumption frequency of wine; Nezlek and Forestell (2020) found that openness to experience was associated with less food neophobia; and several studies found that neuroticism was negatively, and openness to experience, conscientiousness and agreeableness were positively related to healthier dietary patterns, better self-rated health and lower BMI (e.g., Pfeiler and Egloff, 2020; Weston, Edmonds, and Hill, 2020). For a recent review of the relationships between the OCEAN traits and food choice and consumption see Machado-Oliveira et al. (2020).

The OCEAN traits have been included in some studies to explain preferences for labeling of GM foods, WTP, and risk perceptions about such foods. Peschel et al. (2019) found that openness to experience and neuroticism were associated with preference for production method labeling such as GM-free and pesticide free labeling of Medjool date in the US. DeLong and Grebitus (2018) found that conscientiousness individuals were more likely to desire labelling of GM sugar and soft drinks with GM sugar contents. Lin et al. (2019) found that openness to experience increased WTP for GM pork in Italy, China and the US, while conscientiousness decreased this WTP in Italy and the US, but not in China. They also

found that extraversion positively and agreeableness negatively were associated with WTP for GM pork in the US only. Ardebili and Rickertsen (2020) found that higher score of conscientiousness decreased the WTP to avoid GM-fed and GM salmon among Norwegians, while higher score of agreeableness increased the premiums to avoid these two products. Whittingham, Boecker, Grygorczyk (2020) used publicly available communication data from Twitter accounts to obtain users' perception about safety of GM food and to identify their personality traits and Schwartz' basic values. Their results indicated that higher score of extraversion was positively associated with the perception that GM food is unsafe, while higher scores of openness to experience, agreeableness, and neuroticism were negatively associated with this perception. Moreover, they found that self-transcendence values such as universalism and benevolence were associated with the perception that GM food is unsafe.

2.3. Effects of knowledge, beliefs, and information on GM aversion

Consumers' preferences and attitudes towards GM foods have been investigated in numerous studies from different perspectives over the last two decades and there are several reviews (e.g., Costa-Font, Gil, and Trail, 2008; Frewer et al., 2013; Scott et al., 2018; Wunderlich and Gatto, 2015). Several recent studies have focused on the effects of knowledge or beliefs on GM aversion and pointed that lack of objective knowledge is a potential barrier against acceptance of these products. For example, Fernbach et al. (2019) showed that in representative samples obtained from US, France, and Germany the extreme opponents of GM food were in fact those who knew the least about genetics, but perceived themselves to be knowledgeable. McFadden and Lusk (2016) also found that US consumers overestimated their own level of knowledge about GM food. Therefore, studies suggest that subjective knowledge and beliefs are more important in determining attitudes towards GM products (e.g., House et al., 2004). Dixon (2016) showed that information had little to no effects on individuals with already negative beliefs about GM food. Using a Bayesian updating approach and a choice experiment Ortega et al. (2020) found that consumers were most responsive to information treatments when they were most uncertain about their preferences for GM pork. Ardebili and Rickertsen (2020) found that Norwegians who lacked information about domestic restrictions on the use of genetic engineering had more positive

attitudes towards GM food. Some studies suggested that labeling would create negative perceptions about GM products (e.g., Lefebvre, Cook, and Griffiths (2019). However, after the mandatory labeling was implemented in the state of Vermont in the US, Kolodinsky and Lusk (2018) used difference-in-difference estimates of GM aversion and found that opposition to GM food was dropped by 19% after this labeling policy.

2.4. WTP for GM food

Numerous studies have estimated the WTP premiums to avoid GM food or valuation of these products. For reviews see for example Hess et al. (2016), Colson and Rousu (2013); Dannenberg (2009), and Lusk et al. (2005). Quite large variations in the premiums for conventional products or discounts for GM products have been found across samples, products and countries. For example, Rickertsen, Gustavsen, and Nayga (2017) estimated average premiums of 7-9% to avoid GM soybean oil, GM-fed salmon, and GM salmon in Norway and the US, while Ardebili and Rickertsen (2020) found twice as high premiums for the same products in a different Norwegian data set. Waterfield, Kaplan, and Zilberman (2020) found an average of 18% price premium for GM-free cereal breakfast among US respondents. Muringai, Fan, and Goddard (2020) found that Canadians require around 70-80% discounts for frozen French fries from potatoes produced with genetic technologies including cisgenic/intragenic, transgenic, and gene editing. Lin et al. (2019) found that US, Chinese, and Italian respondents required a discount of around 40%, 80%, and more than 280% per pound of GM pork, respectively. Hess et al. (2016) conducted a meta-analysis of 1,713 questions about consumers' evaluations of GM food from respondents in 214 different studies.[1] They found that consumers evaluation of GM food does not depend on the type of the food product, more positively framed questions are associated with more positive evaluations of GM food, and that EU consumers are not more GM averse than the rest of the countries when negative/positive connotations of survey questions are controlled for.

3. Materials and Methods

[1] Hess et al. (2016) defined evaluation as quantitative measures of consumers' acceptance, perceptions, attitudes.

3.1. The survey

An online survey was conducted between October and November 2015 in Norway and the US. Data were collected by a market research agency (Ipsos), who randomly recruited respondents across regions in both countries.[2] More than 1,000 respondents participated in each country (1,037 in Norway and 1,025 in the US). The respondents could quit the survey whenever they wanted and were assured that their information was anonymous. The survey included a choice experiment on food values and questions about sociodemographic factors, attitudes, and personality traits.

3.2. Measurements of the variables and descriptive statistics

The WTP to avoid GM products were based on the respondents' answers to three questions: (1) "Imagine that you are purchasing soybean oil. The store has two types of oil. The first is made from non-genetically modified soy, and the other is made from genetically modified soy. How much more are you willing to pay for the non-genetically modified oil as compared with the genetically modified oil?". (2) "Imagine that you are purchasing salmon. The store has two types of salmon. Non-genetically modified soy has been a part of the feed of the first type of salmon and genetically modified soy has been a part of the feed of the other type. How much more are you willing to pay for the salmon that has been fed non-genetically modified soy?". (3) "Imagine a genetically modified salmon has been developed. The store has conventional farmed salmon and the genetically modified salmon. How much more are you willing to pay for conventional salmon?". The respondents could choose one of the following alternatives "nothing, will not pay more", "a maximum of 20% more", "21-50% more", "more than 50% more", and "do not know".

Table 1 presents the percentage distribution of the WTP values to avoid three GM alternatives in Norway and the US. The last row of the table reports the *p*-values of a Kruskall-Wallis test for whether the samples originate from the same distribution. We can reject identical distribution of WTP values for GM salmon, but not for GM soybean oil and

[2] More information can be found in https://www.ipsos.com/nb-no/samfunnsundersokelsen-norsk-monitor

GM-fed salmon. Following Rickertsen, Gustavsen, and Nayga (2017), we removed all respondents who chose the 'do not know' alternative for at least one good, and 291 Norwegian observations and 202 US observations were removed. The subsequent descriptive statistics and analyses are therefore based on 746 Norwegian and 824 US observations.

Table 1. Willingness to pay to avoid GM alternatives, percentage distributions

	Norway (N = 1,037)			United States (N = 1,026)		
	GM soybean oil	GM-fed salmon	GM salmon	GM soybean oil	GM-fed salmon	GM salmon
Nothing	43.8	44.6	38.6	48.4	47.1	51.1
1-20% more	28.8	31.2	36.3	28.9	28.2	26.0
21% - 50 more	4.4	5.1	6.7	7.9	10.3	7.5
> 50% more	3.1	2.2	3.8	2.8	3.0	5.7
"Do not know"	19.9	16.8	14.8	11.9	11.4	9.7
P-value [a]	0.75	0.18	0.00			

Source: The table is based on information in Table 3 in Rickertsen, Gustavsen, and Nayga (2017).
[a] The *p*-value of the Kruskall-Wallis test on whether the samples originate from the same distribution. We found a different result than Rickertsen, Gustavsen, and Nayga (2017) for this test on WTP values to avoid GM soybean oil and GM-fed salmon.

Table 2 provides the descriptive statistics of the sociodemographic variables. The description of the variables is provided in the second column. Respondents' age was measured in year. Households' income was measured in US$ in the US and in NOK in Norway and was recorded in nine intervals. The respondent's income was set to the midpoint of the income group, except for the highest and lowest income groups where the censoring point was set as the income, and the log of income levels is used in the subsequent analyses. A set of dummy variables was used for respondents' sociodemographic characteristics including gender (1 if male), education (1 if completed a bachelor's degree or more), marital status (1 if married or live with his/her partner), children (1 if children aged 18 or younger lives in the household), farm (1 if the respondent lives or ever lived in a farm), place of residence, (1 if the respondent lives in an area with more than 100,000 inhabitants).

Mean values and the standard deviations of the sociodemographic variables in Norway and the US are provided in columns 3 to 6 in Table 2. The last column of the table reports the *p*-values of an unpaired *t*-tests for identical mean values in the two countries for the continuous age and income variables, and the *p*-values of a non-parametric Pearson's

chi-squared test of the independence of the binary variables from the samples. Except for gender, the observed differences in Norway and the US for education, marital status, children, farm, and city are significant. Moreover, age and income also have significantly different means in the two countries. The Norwegian respondents are on average older, wealthier, and more educated. A larger proportion is also married and live or has lived on a farm, and a lower proportion is residing in cities and has children living in the household.

Table 2. Mean and standard deviations (SD) of the sociodemographic variables

		Norway (N = 746)		United States (N= 824)		
Variable	Description	Mean	SD	Mean	SD	P-value
Age	Age of respondent in year	53.93	15.03	40.45	12.70	0.00 [b]
Income	Log of household's income in US$ in the US and NOK in Norway [a]	6.16	0.81	3.89	0.72	0.00 [b]
Male	= 1 if male	0.52	0.50	0.52	0.50	0.97 [c]
Education	= 1 if completed bachelor or more	0.64	0.48	0.55	0.50	0.00 [c]
Married	= 1 if married or cohabitant	0.71	0.46	0.57	0.49	0.00 [c]
Children	= 1 if children aged 18 years or less live in the household	0.30	0.46	0.44	0.50	0.00 [c]
Farm	= 1 if lives or has lived on a farm	0.32	0.47	0.19	0.39	0.00 [c]
City	= 1 if lives in city > 100,000 inhabitants	0.29	0.45	0.43	0.50	0.00 [c]

Source: The table is based on the information in Table 4 in Rickertsen, Gustavsen, and Nayga (2017). However, the values for the Farm variable are different in this table as a result of some typos in Rickertsen, Gustavsen, and Nayga (2017).

Notes: [a] The income was divided in nine income groups, and the respondent's income was set to the midpoint of the income group. For the highest and lowest income groups, the censoring point was set as the income. Income was measured in US$ in the US and in NOK in Norway. [b] The *p*-value of an unpaired *t*-test for identical mean values in Norway and the US. A significant result indicates the means of the continuous variable are significantly different across the samples. [c] The *p*-value of a Pearson's chi-squared test of independence of the binary variable from the samples in Norway and the US. A significant result indicates that the difference in the observed binary variable across the samples is significant.

The personality traits were measured by a short version of the Big Five model proposed by Engvik and Clausen (2011), based on 20 items; BFI-20. Table 3 presents the personality traits, their definition according to American Psychology Association's dictionary (APA, 2007), and the associated items according to BFI-20. The items were measured by self-reported scores on a scale from 1 (the item does not describe the

Table 3. The Big Five personality traits, their definition, and mean and standard deviations (SD) of the items included in the OCEAN traits

		Norway (N = 746)		United States (N= 824)	
Traits	APA definition [a]	Mean [b]	SD [b]	Mean [b]	SD [b]
Openness to Experience					
Original	The tendency to be open to new aesthetic, cultural, or intellectual experiences	4.14*	1.35	4.93*	1.42
Imaginative		4.53*	1.51	5.12*	1.46
Ideas		4.28*	1.44	4.99*	1.38
(non) Unaesthetic [c]		4.45*	1.87	4.18*	1.89
Conscientiousness					
Thorough	The tendency to be organized, responsible, and hardworking	5.63	0.99	5.66	1.28
(non) Careless [c]		4.80	1.41	4.66	1.67
(non) Messy [c]		5.51*	1.53	4.85*	1.76
Discipline		4.89*	1.23	5.17*	1.41
Extraversion					
Talkative	An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience	4.06*	1.48	4.29*	1.66
(non) Quiet [c]		4.16*	1.63	3.60*	1.68
(non) Shy [c]		5.06*	1.47	3.85*	1.72
Social		4.66	1.45	4.67	1.62
Agreeable					
Helpful	The tendency to act in a cooperative, unselfish manner	5.22*	1.19	5.43*	1.37
(non) Cold [c]		5.10*	1.40	4.45*	1.67
Friendly		5.65	1.06	5.63	1.28
(non) Rude [c]		5.05	1.48	4.91	1.67
Neuroticism					
Depressed	A chronic level of emotional instability and proneness to psychological distress	2.38*	1.44	3.05*	1.76
(non) Relaxed [c]		3.06*	1.42	3.39*	1.63
Worried		3.56*	1.69	4.20*	1.89
Nervous		2.90*	1.54	3.77*	1.80

Notes: [a] Definitions according to American Psychology Association's (APA) Dictionary of Psychology (APA, 2007).[b] Mean values with standard deviations of the 20 items of BFI-20. An asterisk indicates significance at the 5% significance level for an unpaired *t*-test of identical mean values in Norway and the US [c] The score of the item is reversed.

respondent at all) to 7 (the item describes the respondent very well). The last four columns of Table 3 report the mean values and standard deviations of the 20 items for each country. The scores of the items with negative wordings are reversed, and higher mean values indicate higher level of the associated trait. An asterisk indicates a significant difference (5%

level) between the mean values of the items across the countries. Except for five items, mean scores are significantly different in two countries at the 5% significance level.

For each individual and each trait, the trait score is constructed from the mean scores of the four associated items. Table 4 reports the averages scores, standard deviation, and Cronbach's alpha reliability coefficients for each constructed trait in each country in columns 2 to 4. In both countries respondents on average identify themselves to be high on conscientiousness and agreeableness and low on neuroticism. Cronbach's alpha values represent scale reliability coefficients from the standardized items used to construct the personality traits, and values above 0.6 suggest construct reliability (Hair et al., 2014: 619). Except for conscientiousness in Norway, all Cronbach's alpha values indicate sufficient construct reliability. Correlation matrix of the constructed OCEAN traits in each country is provided in the last five columns of the table and an asterisk indicate significance at 5% level.

Table 4. Correlation matrix of the OCEAN traits

				Covariance matrix [c]				
	Mean[a]	SD [a]	α[b]	O	C	E	A	N
Norway (N = 746)								
Openness to Experience	4.35	1.12	0.72	1.00				
Conscientiousness	5.21	0.86	0.58	0.00	1.00			
Extraversion	4.49	1.21	0.82	0.19*	0.12*	1.00		
Agreeable	5.26	0.87	0.62	0.06	0.39*	0.32*	1.00	
Neuroticism	2.98	1.17	0.77	-0.08*	-0.23*	-0.29*	-0.21*	1.00
United States (N = 824)								
Openness to Experience	4.80	1.02	0.61	1.00				
Conscientiousness	5.08	1.05	0.61	0.26*	1.00			
Extraversion	4.10	1.21	0.70	0.23*	0.21*	1.00		
Agreeable	5.11	1.05	0.66	0.26*	0.50*	0.18*	1.00	
Neuroticism	3.60	1.35	0.75	-0.17*	-0.45*	-0.33*	-0.33*	1.00

Notes: Notes: [a] Mean values with standard deviations for the constructed traits. [b] Cronbach's alpha values represent scale reliability coefficients from the standardized items. [c] Covariance matrix of the OCEAN traits. An asterisk indicates significance at the 5% significance level.

Although several correlations are significant, none is above 0.5. For better interpretability of the results, the trait scores were standardized to have zero mean and unit standard deviation, and these standardized scores are used in the subsequent analyses.

We used the 12 food values suggested by Bazzani et al. (2018). As compared with Lusk and Briggeman (2009) the value 'tradition' is excluded and the values 'novelty' and 'animal welfare' are added. Table 5 provides the 12 food values and their definitions. The method used for eliciting the preferences over relative importance of the food values and the descriptive statistics of these preferences are explained below.

Table 5. Food values with descriptions

Food value	Description
Naturalness	Made without modern food technologies like genetic engineering, hormone treatment and food irradiation
Safety	Eating the food will not make you sick
Environmental impact	Effects of food production on the environment
Origin	Whether the food is produced locally, in the US/Norway or abroad
Fairness	Farmers, processors and retailers get a fair share of the price
Nutrition	Amount and type of fat, protein, etc.
Taste	The flavor of the food in your mouth
Appearance	The food looks appealing and appetizing
Convenience	How easy and fast the food is to cook and eat
Price	Price you pay for the food
Animal welfare	Well-being of farm animals
Novelty	The food is something new that you have not tried before

Source: The table is based on the information in Table 2 in Bazzani et al. (2018).

3.3. Best-worst scaling method

The best-worst scaling (BWS) method was developed by Finn and Louviere (1992). There are several ways to implement the method, and we used an approach that is commonly used in studies of food values (e.g., Bazzani et al, 2018; Lister et al. 2017; Lusk and Briggeman, 2009; Pappalardo and Lusk, 2016). Repeated choice sets that include a random subset of the food values were designed. In each choice set, respondents were asked to choose the food value that was of most and least importance to them. As explained in Bazzani et al. (2018), a nearly balanced incomplete block design (NBIBD) was used in this choice

experiment. Twelve choice sets were designed, each set included four food values, and each value was repeated four times across the sets and paired with other values 1.09 number of the times. All respondents were given all the choice sets, and were allowed to only choose one pair of the most important (best) and least important (worst) food value in each set. A more detailed discussion of the BWS method and this choice experiment is provided in Bazzani et al. (2018).

Following Pappalardo and Lusk (2016), we used the count method to calculate the respondent-specific scores for the importance of each food value. For each respondent, we counted the number of the times each food value was chosen as most important and the number of the times each food value was chosen as least important across the 12 choice sets. We then subtracted the number of times it was chosen as least important from the number of times it was chosen as most important and obtained the best-worst score. These scores are referred to as the 'importance scores' or 'best-worst scores' (Lusk and Briggeman, 2009; Pappalardo and Lusk, 2016). Since each food value appeared four times across the 12 choice sets, the range of the importance scores are from -4 to 4, and they sum to zero across all food values, i.e., the importance scores are effect coded and zero implies the mean level of importance.

Table 6 reports the descriptive statistics for the 12 food values based on the counting method. For each country, the Best (Worst) column reports the average best (worst) scores, i.e., the number of the times each food value was chosen as most (least) important across the 12 choice sets. The sum of the mean values in the Best column and the sum of the mean values in the Worst column is 12 for each country, indicating everyone in the sample chose one food value as most important and one food value as least important in all choice sets. The Best-Worst column reports the average of the best minus the worst scores and the column has to sum to zero. The last column reports the results of an unpaired *t*-test of identical mean values of the best minus worst score for each food value in Norway and the US. Except for safety and taste, the average best minus worst score is significantly different in the two countries for each food value at the 5% significance level. According to the average best-worst scores, safety is the most important, and novelty is least important food value in both countries. In the remainder of the paper, we refer to these best-worst scores as importance scores.

Table 6. Descriptive statistics of the food values [a]

	Norway (N = 746)			United States (N = 824)			
	Best	Worst	Best-Worst	Best	Worst	Best-Worst	P-value [b]
Safety	2.42	0.09	2.34	2.40	0.22	2.19	0.07
	(1.30)	(0.36)	(1.46)	(1.42)	(0.58)	(1.77)	
Naturalness	1.48	0.43	1.05	1.16	0.83	0.33	0.00
	(1.37)	(0.84)	(1.90)	(1.25)	(1.04)	(2.01)	
Environmental	0.93	0.70	0.23	0.68	0.88	-0.20	0.00
impact	(1.07)	(0.95)	(1.70)	(0.91)	(1.06)	(1.66)	
Fairness	1.00	0.64	0.36	0.65	0.98	-0.32	0.00
	(1.12)	(0.94)	(1.76)	(0.86)	(1.01)	(1.54)	
Nutrition	1.19	0.58	0.61	1.37	0.48	0.89	0.00
	(1.26)	(0.88)	(1.85)	(1.18)	(0.78)	(1.67)	
Taste	1.43	0.27	1.16	1.65	0.37	1.28	0.16
	(1.38)	(0.52)	(1.64)	(1.33)	(0.70)	(1.74)	
Price	0.83	1.36	-0.53	1.34	0.89	0.45	0.00
	(1.22)	(1.20)	(2.15)	(1.28)	(1.09)	(2.09)	
Appearance	0.48	1.42	-0.95	0.63	1.17	-0.54	0.00
	(0.75)	(1.13)	(1.65)	(0.77)	(1.14)	(1.65)	
Animal welfare	1.02	0.34	0.68	0.79	0.77	0.02	0.00
	(1.34)	(0.76)	(1.73)	(1.13)	(1.12)	(1.86)	
Origin	0.81	1.50	-0.69	0.64	1.56	-0.92	0.02
	(1.11)	(1.25)	(2.09)	(0.86)	(1.15)	(1.77)	
Convenience	0.34	1.83	-1.49	0.50	1.39	-0.89	0.00
	(0.75)	(1.21)	(1.71)	(0.76)	(1.17)	(1.68)	
Novelty	0.08	2.86	-2.78	0.19	2.47	-2.28	0.00
	(0.33)	(1.20)	(1.36)	(0.51)	(1.33)	(1.62)	

Notes: [a] Mean values of the scores obtained from counting method with standard deviations in the parentheses. [b] The *p*-value of an unpaired *t*-test for identical mean values in Norway and the US.

3.4. Subjective expected utility and WTP

In expected utility theory, the probabilities are usually assumed to be objective facts. However, in food choice situations such objective probabilities are typically unknown and likely to be measured by subjective and respondent specific probabilities. Following Lusk (2011b); Lusk, Schroeder, and Tonsor (2014); and Pappalardo and Lusk (2016), we interpret the subjective probabilities as subjective beliefs. Assume one respondent who is consuming

a product that exists in different varieties each with different attributes. Let P_{ij}^{k} be the respondent's i subjective belief that variety j provides attribute k where $k = 1, \dots, K$. We follow Lusk (2011b) and Pappalardo and Lusk (2016), and interpret the attributes as food values, and the utility obtained from each food value is $U_i(FV_k)$. The subjective expected utility respondent i gets from variety j is SEU_{ij}, and it can be expressed as:[3]

$$SEU_{ij} = \sum_{k=1}^{K} P_{ij}^{k} U_i(FV_k). \quad (1)$$

Variety A of the product will be chosen over variety B when $SEU_{iA} > SEU_{iB}$, or in terms of Equation (1) when $\sum_{k=1}^{K}\left(P_{iA}^{k} - P_{iB}^{k}\right)U_i(FV_k) > 0$.

We extend the model in Lusk (2011b) and Pappalardo and Lusk (2016) and let the SEU be associated with respondent-specific characteristics such as sociodemographic status and personality traits. We consider two varieties of the product, one that is a GM variety (GM) and one that is a conventional non-GM variety (C). The SEU of respondent i for the GM variety is:

$$SEU_{iGM} = \gamma_{GM} + \sum_{k=1}^{K} P_{iGM}^{k} U_i(FV_k) + \sum_{l=1}^{L} \beta_{GM}^{l} Z_{il} - \alpha price_{GM} \quad (2)$$

where γ_{GM} is a constant term, Z_{il} is the level of respondent-specific characteristic l, β_{GM}^{l} is the associated parameter, α is the marginal utility of income, and $price_{GM}$ is the price of the GM variety.

The SEU for the conventional variety is:

$$SEU_{iC} = \gamma_{C} + \sum_{k=1}^{K} P_{iC}^{k} U_i(FV_k) + \sum_{l=1}^{L} \beta_{C}^{l} Z_{il} - \alpha price_{C}. \quad (3)$$

As discussed in Section 2, many studies have confirmed that price discounts are needed to make individuals willing to accept GM products (e.g., Ardebili and Rickertsen, 2020; Lin et al., 2019; Lusk et al., 2005). Consequently, we assume that there is a WTP premium for the conventional product as compared with its GM counterpart. This premium is calculated by solving for the price difference that equates the SEUs in Equations (2) and (3), or:

$$WTP = (price_{C} - price_{GM}) = \frac{(\gamma_C - \gamma_{GM}) + \sum_{k=1}^{K}\left(P_{i,C}^{k} - P_{iGM}^{k}\right)U_i(FV_k) + \sum_{l=1}^{L}(\beta_{C}^{l} - \beta_{GM}^{l})Z_{il}}{\alpha}. \quad (4)$$

[3] Equation (1) is a subjective expected utility theory model (Savage, 1954). Subjective expected utility theory is an extension of the expected utility theory of von Neumann and Morgenstern (1944).

3.5. Econometric model

Each respondent had stated the WTP intervals to avoid three different GM and non-GM products, and we used a random effects interval regression model to take this panel structure into account. Following Rickertsen, Gustavsen, and Nayga (2017), we specified each respondent's WTP to avoid the GM varieties as:

$$WTP_{i,GM} = G_1 X'_i \lambda_1 + G_2 X'_i \lambda_2 + G_3 X'_i \lambda_3 + v_i + e_{i,GM} \quad (5)$$

where subscript GM denotes the GM varieties of three products (GM soybean oil, GM-fed salmon, and GM salmon); $G_1 = 1$ for the first product and 0 otherwise, $G_2 = 1$ for the second product and 0 otherwise, and $G_3 = 1$ for the third product and 0 otherwise; X'_i is a vector of the explanatory variables, and $\lambda_1, \lambda_2,$ and λ_3 are the parameter vectors. The respondent-specific random variation v_i is assumed to be constant across products and iid $N(0, \sigma_v^2)$. The observation-specific random variation $e_{i,GM}$ is assumed to be independent of v_i and $N(0, \sigma_e^2)$. The proportion of the total variance contributed by the panel-level variance component is $\rho = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_e^2}$. When this proportion is high, the respondent-specific variation is high, the panel structure is important, and a pooled estimator will give incorrect standard errors. We used the -xtintreg- procedure in Stata/MP 15 to estimate the model.

4. Results

We estimated three models for each country: Model 1 included sociodemographic variables; Model 2 included sociodemographic variables and personality traits; and Model 3 included sociodemographic variables, personality traits, and food values. In Model 3, the score of 'price' was excluded to avoid perfect multicollinearity among the food values (the sum of the best minus worst scores is zero by construction).

First, we estimated unrestricted versions of the three models for each country. In these unrestricted models, we allowed product specific marginal effects of the explanatory variables and alternative specific constants (ASCs). Second, we estimated restricted version of the models where we imposed identical marginal effects but allowed ASCs. Third, we tested the restricted against the unrestricted models by likelihood-ratio tests. None of the six restricted models were rejected (all p-values > 0.2), and we report the results of the

restricted models. Finally, we tested the three models against each other in each country by log-likelihood ratio tests. Model 1 ($p < 0.00$) and Model 2 ($p < 0.00$) were rejected as when tested against Model 3 in each country, and we focus our discussion on the restricted version of this model. [4]

4.1. Norway

Table 7 shows the estimated coefficients and associated standard errors of the three Norwegian interval regression models. An asterisk indicate significance at the 5% level. The proportion of the total variance contributed by the panel-level variance component is high in all models ($\rho > 0.81$), which indicates the importance of panel structure of the data.

The ASCs represent the average WTP premiums for a hypothetical reference respondent, i.e., a single zero year old female, with zero income, no university degree, no children, who never has lived on a farm, does not live in a city, scores zero on all personality traits, and find all the food values to have average importance. None of the ASCs are significantly different from zero.

Some sociodemographic effects, no OCEAN traits, and many food values are significantly associated with the WTP premiums to avoid GM foods. The coefficients can be interpreted as the change in the WTP premium for a non-GM food as a result of a one unit increase in the associated variable. Income and farm were both positively associated with higher WTP to avoid the GM alternatives. Education had the greatest impact on WTP; respondents who had completed a bachelor's degree or more had on average 2.5 percentage points higher WTP premium to avoid GM food than others.

The significant food values illustrate the importance of subjective beliefs. A change in the importance of a food value is relative to the importance of price, i.e., the excluded food value. Furthermore, for the food values these coefficients reflect the difference in subjective beliefs about the conventional product versus the GM alternative with respect to each food value (Lusk, 2011b; Pappalardo and Lusk, 2016). The effects of the food values imply that respondents perceived non-GM foods to be more safe, more natural, with less negative

[4] We also tested Model 1 against Model 2. Model 1 was not rejected ($p = 0.39$) when it was tested against Model 2 using the Norwegian sample.

Table 7. Coefficient estimates and associated standard errors, Norway [a]

	Model 1		Model 2		Model 3	
Variable	Coefficient	SE	Coefficient	SE	Coefficient	SE
Age	0.03	0.03	0.04	0.03	-0.00	0.03
Income	1.56*	0.61	1.57*	0.61	1.30*	0.56
Male	-3.09*	0.92	-3.00*	0.96	-0.27	0.92
Education	2.92*	0.97	2.81*	0.97	2.52*	0.91
Married	-0.49	1.05	-0.31	1.06	0.48	0.98
Children	0.32	1.07	0.48	1.07	0.30	1.00
Farm	3.21*	1.01	3.34*	1.00	2.20*	0.94
City	0.40	1.03	0.20	1.04	0.20	0.95
Openness [b]			0.64	0.46	0.27	0.44
Conscientiousness [b]			0.66	0.56	0.88	0.52
Extraversion [b]			-0.35	0.51	-0.07	0.48
Agreeableness [b]			-0.12	0.58	-0.34	0.53
Neuroticism [b]			0.77	0.55	0.79	0.51
Safety					1.04*	0.34
Naturalness					2.24*	0.33
Environmental impact					1.81*	0.35
Fairness					1.23*	0.32
Nutrition					0.60	0.33
Taste					0.38	0.43
Appearance					1.40*	0.37
Animal welfare					1.13*	0.37
Origin					1.24*	0.29
Convenience					1.48*	0.40
Novelty					0.83	0.44
ASC GM soybean oil	-4.73	3.88	-4.98	3.87	-3.00	3.95
ASC GM-fed salmon	-4.83	3.88	-5.08	3.87	-3.11	3.95
ASC GM salmon	-3.20	3.88	-3.45	3.87	-1.48	3.95
N [c]	2,238		2,238		2,238	
Log likelihood	-4,858		-4,855		-4,787	
AIC	9,743		9,748		9,632	
BIC	9,817		9,850		9,798	
ρ	0.84		0.84		0.81	
p-value LR-test [d]			0.38		0.00	

Notes: [a] An asterisk implies significance at the 5% level. [b] Standardized net traits. [c] Balanced panel with three observations per respondent (748 respondents). [d] The p-values for the significance of adding the personality traits to Model 1 and adding the food values to Model 2.

impact on the environment, and a better area of origin than the GM alternatives. They also perceived the non-GM foods to be fairer, look more appealing, better for the welfare of animals, and more convenient than the GM alternatives. A one unit increase in the importance scores of these food values relative to the importance score of price, increased the WTP premium for the conventional products between 1.1 and 2.2 percentage points.[5]

4.2. The US

Table 8 presents the estimated coefficients and associated standard errors from the interval regression models for the US. The proportion of the total variance contributed by the panel-level variance component in each model is quite high ($\rho > 0.62$). All the ASCs are statistically significant, two sociodemographic variables, two personality traits, and many food values are significant. Age was negatively associated with WTP to avoid GM foods, and farm had the greatest impact on WTP. Respondents who live or have lived on a farm had on average 3.7 percentage points higher WTP premiums to avoid GM food than others.

A one standard deviation increase in the score of extraversion increased the WTP premium to avoid GM, and one standard deviation increase in the score of agreeableness decreased the WTP premium to avoid GM foods by around 1.0 percentage point.

The effects of the food values imply that respondents perceived non-GM foods to be more natural, more nutritious, with less negative impact on the environment, fairer, and with more appealing look than the GM alternatives. They also perceived the non-GM foods to be better for the animal welfare, more convenient, with a better area of origin, and somewhat surprisingly to be more novel than the GM alternatives. A one unit increase in the importance scores of these food values relative to the importance score of price, increased the WTP premium for the conventional products between 1.0 and 2.9 percentage points.

[5] We excluded price from the model because we expected that price sensitive respondents would have higher acceptance of GM foods, and the findings correspond well with this hypothesis.

Table 8. Coefficient estimates and associated standard errors, United States [a]

	Model 1		Model 2		Model 3	
Variable	Coefficient	SE	Coefficient	SE	Coefficient	SE
Age	-0.25*	0.03	-0.22*	0.03	-0.12*	0.03
Income	1.39*	0.70	1.28	0.69	1.12	0.64
Male	1.37	0.87	1.05	0.87	0.09	0.82
Education	0.22	0.94	0.15	0.92	0.13	0.85
Married	0.35	0.98	0.61	0.96	-0.05	0.88
Children	2.36	0.92	2.09*	0.90	1.44	0.83
Farm	5.52*	1.09	4.91*	1.08	3.75*	1.00
City	2.30*	0.86	1.81*	0.84	0.76	0.77
Openness [b]			0.65	0.44	0.13	0.41
Conscientiousness [b]			-1.01	0.52	-0.35	0.48
Extraversion [b]			1.54*	0.45	1.11*	0.41
Agreeableness [b]			-1.73*	0.49	-1.03*	0.46
Neuroticism [b]			0.41	0.50	0.69	0.46
Safety					0.50	0.28
Naturalness					1.95*	0.28
Environmental impact					1.35*	0.31
Fairness					1.42*	0.33
Nutrition					1.05*	0.31
Taste					0.72	0.38
Appearance					1.75*	0.34
Animal welfare					1.19*	0.31
Origin					1.53*	0.29
Convenience					1.93*	0.34
Novelty					2.95*	0.32
ASC GM soybean oil	8.71*	2.85	8.29*	2.86	14.88*	2.70
ASC GM-fed salmon	9.37*	2.85	8.94*	2.86	15.53*	2.70
ASC GM salmon	9.74*	2.85	9.32*	2.86	15.90*	2.70
N [c]	2,472		2,472		2,472	
Log likelihood	-6,144		-6,120		-6,046	
AIC	12,314		12,275		12,150	
BIC	1,2390		1,2380		1,231	
ρ	0.69		0.67		0.62	
p-value LR-test [d]			0.00		0.00	

Notes: [a] An asterisk implies significance at the 5% level. [b] Standardized net traits. [c] Balanced panel with three observations per respondent (824 respondents). [d] The p-values of likelihood ration tests for the significance of adding the personality traits to Model 1 and adding the food values to Model 2.

5. Discussion, Implications, and Limitations

Sociodemographic factors influence the WTP to avoid GM food. Living on a farm increases the WTP to avoid GM food in both countries. Similar resistance has been found in several other studies. Lehrman and Johnson (2008) found that a majority of Swedish farmers have negative attitudes towards GM crops; Lawson et al. (2009) found that 28% of the Danish farmers were negative towards growing GM crops; and Todua and Gogitidze (2017) found similar resistance among Georgian farmers. In Norway, income and education are associated with increased GM aversion, and in the US, increasing age is associated with GM acceptance which corresponds with the results reported in Rickertsen, Gustavsen, and Nayga (2017) and findings in Ardebili and Rickertsen (2020).

The associations between personality traits and attitudes towards GM food do not follow the previous findings. In the US, extraversion is positively, and agreeableness is negatively associated with WTP to avoid GM foods, which seem to be at odd with the results in Lin et al. (2019) who found opposite associations of these traits with valuation of GM pork in the US. Moreover, in contrast to the findings in the Ardebili and Rickertsen (2020), the OCEAN traits are not associated with the WTP to avoid GM products in Norway. This is a surprising result as the food products, measurement of the attitudes, and Big Five personality traits in this work are identical to the ones used in Ardebili and Rickertsen (2020). However, they did not include food values and constructed the personality traits using a different approach than this paper.[6] Moreover, the sample characteristics or the data collection method could have also contributed to the non-replication of the results.

Prior to this paper, three studies investigated the associations between OCEAN traits and attitudes towards GM food in different countries. Attitudes were measured by WTP to avoid three GM products in Norway (Ardebil and Rickertsen, 2020), WTP for GM pork in US, China, and Italy (Lin et al., 2019), and perceptions about the safety of GM food among Twitter user accounts (Whittingham, Boecker, and Grygorczyk, 2020). Findings from these studies and the current paper, revealed inconsistencies and non-replication of the results across the products and samples. However, the product specific associations between personality traits

[6] Ardebili and Rickertsen (2020) conducted a confirmatory factor analysis (CFA), predicted the scores of the five traits for each individual, and adjusted the resulting scores for individuals' age.

and food preferences have been reported for other products than GM food as well (e.g., Bazzani et al., 2017; Gustavsen and Rickertsen, 2019). These findings call for further investigation of the role of OCEAN traits in determining attitudes towards GM food.

The subjective beliefs about GM foods are similar in both countries. In both countries, respondents perceive the GM products to be cheaper than the conventional products. However, they believe that conventional products are more natural; better for animal welfare; have less negative environmental impacts, and more likely to be produced locally. Moreover, the respondents believe that application of GM technology is not fair towards farmers, processors, and retailers. This perception about unfairness of GM technologies is in line with findings in Lusk, McFadden, and Wilson, (2018). In particular, they found that consumers' concerns about the distributional effect of adopting GM technologies across the food supply chain affect attitudes towards GM food. Perceived negative environmental impacts and unnaturalness of GM food relative to conventional products is also in line with twenty-year-old results that found consumers perceive GM food to be unnatural and with long-term consequences on human health and environment (Bredahl, 1999; Frewer, Howard, and Shepherd, 1996). The stability of these subjective beliefs is in line with the discussion in Tonsor, Lusk, and Schroeder (2018) and Lusk and Briggeman (2009), who argued that preferences over food values are relatively stable. These results are also consistent with Honkanen and Verplanken (2004), who argued that attitudes stemming from more general values are quite stable and less likely to change when the external environment is changing.

There are some differences in subjective beliefs about GM foods in the two countries. First, nutritional beliefs significantly affect the WTP to avoid GM foods in the US, while nutrition has no effect in Norway. Second, safety is insignificant in the US but significant in Norway. This indicates that the US respondents do not believe conventional products to be significantly safer than GM products. This difference in beliefs is reasonable given that genetic engineering has been widely adopted in the US while GM foods are banned in Norway. Previous studies have also suggested that GM food aversion is associated with restrictive government policies (Ardebili and Rickertsen, 2020; Lusk, 2011a; Pakseresht, McFadden, and Lagerkvist, 2017).

Ardebili and Rickertsen (2021) found that the OCEAN traits and food values are associated and recommended to include both constructs in studies of food-related behavior. Our results indicate that food values are more important than personality trait. Huynh and Olsen (2015) studied consumers' attitudes towards home meal preparations, and investigated the role of personality traits and personal values. They also found that personal values have stronger effects on individuals' attitudes than personality traits. However, in their study of consumers' risk perceptions about GM foods among Twitter users, Whittingham, Boecker, and Grygorczyk (2020) found that the role of personal values in determining attitudes towards GM food are mediated by individuals' personality traits. This suggests that benefits can be gained from considering the role of personality traits and values (personal values or food values) in studying consumers' food-related attitudes and behavior.

Our findings have several practical implications. First, a large part of the resistance seems to be based on perceptions that GM foods are less natural, less fair to stakeholders in the supply chain, more harmful to the environment, and bad for the welfare of animals. Given such beliefs credible information is important even though information has not been very successful so far (Batrinou et al., 2005; Dean and Shepherd, 2007; Dixon, 2016; Lusk et al., 2004). The information has to a large extent emphasize the safety of GM foods for human consumption. However, information also needs to address the potential environmental benefits of genetic modification technologies, that these technologies are equally natural as other breeding technologies, and highlight that there is nothing inherent in gene modification technologies that reduce animal welfare or fairness. It is also important to focus on the benefits of the technology for local and domestic production. Second, our results suggest current safety concerns about GM foods may disappear if governments in Europe adopt more liberal policies towards GM foods (Pakseresht, McFadden, and Lagerkvist, 2017). Third, businesses can attract price sensitive consumers by promoting the low prices of GM food products. They could also attract GM avoiders by promoting the environmental benefits of these products such as by creating pesticide-free labeling equivalents.

There are some limitations in this study which could open areas for further research. First, the personality traits were measured using a short version of the Big Five model. A longer version with more items would provide more nuances and possibly affect the results. Second, a nearly balanced incomplete block design (NBIBD) was used for the allocation of

food values across the choice sets in the BWS experiment, while other designs such as balanced incomplete block design (BIBD) have better properties. However, given a fixed number of original items, BIBD imposes restrictions on the size or amount of the choice sets which can result in large -in size or in number of- sets to be included in the experiment. it has been discussed in the literature that complexity and cognitive burden of choice experiments can influence respondents' attentiveness to the choice task (e.g., Caussade et al. 2005; Scarpa and Rose, 2008). Third, the data was collected through an online survey with no control over consumers' attentiveness. As suggested by Lee, Soutar, and Louviere (2008), it can be beneficial if future studies attempt to design experiments that can induce respondents' engagement and attentiveness to the choice tasks. Fourth, the WTPs premiums were stated without real economic incentives, which can potentially lead to a hypothetical bias in stated WTPs. Fifth, the respondents had no alternative to express a positive WTP for the GM alternatives. Previous studies have shown that framing of the questions significantly affect consumers' attitudes and evaluation of the GM food (e.g., Hess et al., 2016; Hu, Adamowicz, and Veeman, 2006). Finally, we asked about consumers WTP to avoid the GM food products with no detail explanation of the technology. As discussed in Lusk, McFadden, and Wilson (2018), the terms GM food or genetic technology are no longer referring to a single product or technology, but rather several possible technologies, and better questions with more nuances are necessary. To include more details about genetic engineering technologies and consider more precise questions in the survey, not only can improve the understanding about consumers' attitudes towards these products, but may also help unfolding the role of personality traits in shaping these attitudes.

6. Conclusions

This is the first paper that links food values to attitudes towards GM foods. We investigated the role of importance level of food values, personality traits and sociodemographic status in determining attitudes towards GM soybean oil, GM-fed salmon, and GM salmon. Attitudes were measured using WTP to avoid GM alternatives. The data was collected using an online survey in Norway and the US. We followed Pappalardo and Lusk (2016) and conceptualized the relationships between food values and WTP to avoid GM food

as indicators of subjective beliefs regarding conventional food products versus GM foods. We found that the effects of sociodemographic status and personality traits on WTP premiums are country specific. Income and education are significant in Norway and age in the US, while living in the farm is significant in both countries. In the US, extraversion and agreeableness are the only traits with significant effects and no traits are significant in Norway.

Most of the food values are significant demonstrating the importance of subjective beliefs. Moreover, the effects of food values are quite consistent across the two countries. An increase in the importance of naturalness, environmental impact, fairness, appearance, animal welfare, origin, and convenience relative to price, increase the aversion towards GM foods. In Norway, we found that respondents perceive GM products to be less safe than conventional products, while there is no such perception in the US. Our results suggest that relevant information and more liberal policies towards GM foods may increase GM acceptance in Europe.

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Paper IV

Sustainable food consumers: Dietary patterns, motives, and personality traits

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Abstract

Transition towards a sustainable food system is a key component of several sustainability goals. A food frequency questionnaire was used to investigate the consumption patterns among Norwegians from a sustainability perspective. Results from a principal component analysis identified three dietary patterns: sustainable, traditional, and unsustainable. The associations between these three dietary patterns and sociodemographic characteristic, personality traits, and food values were investigated using regression analysis. Openness to experience was associated with the sustainable dietary pattern, agreeableness was associated with the traditional dietary pattern, and extraversion was associated with the unsustainable dietary pattern. To reduce environmental impacts is the main motive behind the sustainable food consumption pattern. To protect local production, and fairness towards farmers, processors, and retailers are the main motives behind the traditional food consumption pattern. Convenience and price were the two most important motivations behind the unsustainable dietary pattern, whereas high price and lack of convenience were the most important barriers for the sustainable dietary pattern. The results imply that increasing familiarity, price discounting, and developing fast and easy recipes with sustainable food items may help to decrease the environmental impacts of individuals' diet.

Keywords: Food Frequency Questionnaire, Sustainable consumption pattern, Personality traits, Food value, Principal component analysis.

1. Introduction

The world's population is projected to reach 9.74 billion by 2050 (United Nations, 2019). Increased income levels suggest increasing per capita food consumption of especially livestock products. Given the changes in dietary patterns, a 60% increase in agricultural production over the period 2005 to 2050 is required to feed the world's population (Alexandratos and Bruinsma, 2012: 95). Simultaneously the world food system is faced with

depleted biodiversity, shortage in land, energy, and water resources (e.g., Godfray et al., 2010) and currently contributes to more than a third of total greenhouse gas (GHG) emissions (Intergovernmental Panel on Climate Change, 2019:58).[1] In Norway, the contribution of the agricultural sector amounted to 8.7% of the total GHG emissions in 2019; 4.4 of 50.3 million tones CO2 equivalent (Statistisk sentralbyrå, 2020). With 51% share, enteric fermentation (CH4) from domestic animals is the largest contributor to the GHG emissions in this section (Miljødirektoratet, 2020).

The importance of food security and sustainability issues are also reflected in United Nations' (2015) sustainable development goals where responsible consumption and production is one of the goals. The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) also emphasize sustainability issues and define sustainable and healthy diets as "dietary patterns that promote all dimensions of individuals' health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable" (FAO and WHO, 2019:9). However, using this definition in different geographical locations with different climate, culture and available resources, sustainable and healthy diets would imply different production and consumption of foods in different countries.

To illustrate the complexity of defining healthy and sustainable diets, we may look at local foods, which frequently are considered to be sustainable. Life cycle analysis have shown that the environmental impacts attributable to the agriculture and processing stages of food production are larger than the impact attributable to transport through land or water (Korsæth et al., 2012; Notarnicola et al., 2017). Therefore, it might be better to import products that are sustainably produced rather than consuming foods that are produced locally but in a less sustainable way. Production of red meat is also considered to have high and negative environmental impacts, while poultry production typically is considered to be more environmentally friendly. Some consumers and activists also consider a vegetarian diet as the ultimate sustainable consumption pattern. Such strategies may be less sustainable in a country like Norway with little arable land of which two thirds only is suitable for grass

[1] In this estimate emissions from crop and livestock within the farm gate (9–14%), emissions from land use and land-use change including deforestation and peatland degradation (5–14%), and emissions from supply chain activities (5–10%) are included.

production (Øverby et al., 2017). In this environment, vegetarianism will depend on import of large quantities of fruits and vegetables. In a more mixed diet including some meat, ruminants can be produced using grass-dominated diets based on domestic resources, while production of poultry is likely to be more dependent on import of soybeans and grains (Øverby et al., 2017). Consequently, some production and consumption of meat from ruminants is sustainable and well-adjusted to the local environment.

Consuming organic food is another suggestion to mitigate the environmental impacts of the food system, but the effectiveness of organic farming is often questioned due to its low yields per unit of time and area. Compared to conventional farming, organic farming is known to be favorable in terms of nutrient runoff, soil erosion, pesticide contamination, and promoting biodiversity through richness and evenness of the species (Bengtsson, Ahnström, and Weibull, 2005; Crowder et al., 2010; Eltun, Korsæth, and Nordheim, 2002). However, when the entire life cycle of organic systems is assessed, the benefits fade away. For example, Clark and Tilman (2017) conducted a meta-analysis of life cycle studies from 742 agricultural systems and found that one unit of organic food requires more land and causes more eutrophication than conventional systems. The authors also found that although one unit of organic food uses less energy, it emits similar GHG emissions as conventional production systems. Other studies also confirm that the lower yields of organic farming require land expansion, which results in additional GHG emissions (Seufert, Ramankutty, and Foley, 2012). Scenarios with a 100% conversion to organic food systems suggested that this conversion would result in a reduction of total food output. The reduction would be most severe for cereals, oilseeds and monogastric livestock, and least severe for vegetables and milk (Muller et al., 2017; Smith et al., 2018).

Refsgaard et al. (2012) used life-cycle analysis and studied the whole production chain until farm gate in Norway for four products: Milk, beef, grain and potatoes. They compared the organic production with conventional production methods and found that for all products GHG emissions were lower in organic than in conventional production method. However, more land per production output is used with organic production methods. In particular, they found that on average one unit of organically produced grain uses 70% more, and one unit of organically produced beef uses around 10% more land than conventionally produced alternatives. Oort and Andrew (2016) provided a report from the current

literature on meat, milk, and dairy products with a focus on Norway. They compared the GHG emissions from conventional and organic production of milk and meat in Norway and found that organic farming offers several benefits in terms of preserving the biodiversity, lower ground water pollutions and preventing the soil fertility. However, the climate impacts in terms of GHG emissions from this production method is less promising. In particular, they found that for meat in Norway conventional production of dairy cows produce lower emissions than organic, and for milk, there is no significant difference. Comparing Norway with other Nordic and Western European countries, GHG emission from organic production is higher in Norway. However, there is a large variance in GHG emissions from organic farming between farms which suggests large potentials for emission reductions in the most emitting farms in Norway (Oort and Andrew, 2016).

In general, several studies point to lower yield from organic systems, and therefore, more land use to produce the same level of output as conventional systems. This suggests that at current level of food demand, including the consumption and the level of food loss and waste, a transition to organic farming would result in more land expansion and would not be effective in obtaining a sustainable food system (Clark and Tilman, 2017; Muller et al., 2017; Smith et al., 2018). FAO (2011) estimated that one third of the food produced in the world is either lost in the production and supply chains or wasted at the retail and consumer levels.[2] Of the total food lost and wasted in Norway, 61% occurs at the household level, 22% occurs at the industry and wholesale level, and 17% occurs at the retailer level (Stensgård and Hanssen, 2015). Given these large losses, the reduction of food loss and waste is important for transition towards a sustainable food system.

Novel food technologies such as genetic modification, nanotechnology, cultured meat, and food irradiation have been proposed as solutions to meet the food security and sustainability goals (Trivedi et al., 2016). However, the speed of adopting these technologies has been rather slow in many countries. This slow adoption may be due to consumers limited knowledge about nutrition, food production processes, and the associated environmental

[2] Some data indicate that post-harvest food losses are larger in developing countries (Parfitt, Barthel, and Macnaughton, 2010). However, the Food Loss Index (FLI), i.e., the share of the food lost from post-harvest excluding the retail sector is higher for Northern America and Europe (17%), than the world average (14%) (FAO, 2019).

impacts (Siegrist and Hartmann, 2020). Consumers' evaluations of food from these technologies may largely be based on a heuristic process where a 'natural-is-better' heuristic plays a substantial role (Siegrist and Hartmann, 2020). Ironically, it also seems like the more concerned the consumers are about environmental and sustainability issues, the more negative their perceptions are towards these technologies (e.g., Siegrist and Hartmann, 2020). In addition, campaigns run by non-governmental organizations, farmers' unions, organic trade groups, and environmental organizations have had strong impacts on consumers' negative attitudes towards novel food technology such as genetic engineering (Bonny, 2003; Scott et al., 2018).

There is no clear universal definition of a sustainable diet. In a study of the most recent versions of official dietary guidelines in different countries, only four (Germany, Brazil, Sweden and Qatar) of the eighty-three countries had explicitly included sustainability aspects (Gonzalez Fischer, and Garnett, 2016). Nordic Nutrition Recommendations (NNR) is prepared by the Nordic Council of Ministers and provide the scientific basis for the national official dietary guidelines in Denmark, Finland, Iceland, Norway and Sweden.[3] The latest edition of this document is from 2012. This edition dedicated a chapter to sustainability, but with a focus on the environmental impacts and GHG emissions only (NNR, 2012). However, the forum has put an extensive emphasize to integrate the recent research in sustainable food consumption and production in updating the upcoming edition of the NNR for 2022. In Norway, currently the official dietary guidelines provided by the Norwegian Directorate of Health (Helsedirektoratet, 2015) focus on health and nutrition and not sustainability, and Øverby et al. (2017) evaluated these guidelines from a sustainability perspective. Table 1 presents these dietary guidelines and a brief summary of Øverby and colleagues' sustainability assessment of each advice. They concluded that a varied diet with high intakes of vegetables, fruits, berries, whole-grains and fish, and low intakes of processed meat, red meat, salt and sugar would result in reduced carbon footprint.

[3] Nordic Council of Ministers and Nordic Council are two main official intergovernmental cooperation forums which involve Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and Åland. For more information see https://www.norden.org/en and https://www.helsedirektoratet.no/english/nordic-nutrition-recommendations-2022

This paper has two main objectives. The first objective is to identify the existing dietary patterns in Norway and evaluate these diets from a sustainability perspective. Sustainability research has focused on consumption of single food products and the entire dietary patterns of individuals has typically not been considered. To do so, I will use a nationally representative sample of Norwegians and a data-driven approach. The detected dietary patterns will be discussed from a sustainability perspective based on the evaluations in Øverby et al. (2017) and as presented in Table 1. Second, the associations between dietary patterns and personality traits, food values, and socioeconomic factors are investigated. The role of food values in adopting specific dietary patterns has previously not been studied. Food values reflect consumers' food choice motives, and understanding motivations behind adopting different food consumption patterns is useful for policymakers and organizations working on transition towards a more sustainable food system.

Table 1. Norwegian dietary guidelines and their sustainability aspects

Norwegian Directorate of Health's Guidelines [a]	Sustainability recommendations [b]
1. Enjoy a varied diet with lots of vegetables, fruit and berries, whole-grain foods and fish, and limited amounts of processed meat, red meat, salt and sugar.	1.1) Good advice from sustainability perspective; the advice will generally result in a lower carbon footprint, but the effect can be product specific, more details below. 1.2) From a self-sufficiency perspective, it is best to choose Norwegian products when possible.
2. Maintain a good balance between the amount of energy you obtain through food and drink and the amount of energy you expend through physical activity	2.1) Good advice from sustainability perspective
3. Eat at least five portions of vegetables, fruit and berries every day	3.1) Good advice from sustainability perspective More attention must be paid to Norwegian-produced fruits, berries and vegetables.
4. Eat whole grain foods every day	4.1) Good advice from sustainability perspective
5. Eat fish two to three times a week. You can also use fish as a spread on bread	5.1) Good advice from sustainability perspective as long as the fish is from sustainable sources. 5.2) Fish and seafood have a lower environmental impact than meat, but higher than vegetable products.
6. Choose lean meat and lean meat products. Limit the amount of processed meat and red meat.	6.1) Ruminant-based meat production can be beneficial for biodiversity conservation and other ecosystem services 6.2) Meat production has high carbon footprints 6.3) A certain production and consumption of red meat is important for good utilization of Norwegian land resources.

	6.4) Of red meat, beef should be avoided. 6.5) Processed animal products help to make better use of animal's body, as they also contain parts of the animal that cannot be sold in the form of unprocessed meat. This is sustainable use of resources.
7. Include low-fat dairy foods in your daily diet	7.1) Good advice from sustainability perspective 7.2) The environmental impact of milk processing is small compared to that of milk production itself. 7.3) Separated fat from milk is used to produce more products such as butter, and thus less emissions per unit of product is produced. This also results in less imports of these products.
8. Choose cooking oils, light and liquid margarine, instead of normal margarine and butter	8.1) Good advice from sustainability perspective 8.2) It is desirable to reduce the consumption of palm oil in favor of olive oil and rapeseed oil.
9. Choose foods that are low in salt and limit the use of salt when preparing food and at the table	9.1) The advice has little effect on sustainability and is mostly important for health reasons.
10. Avoid foods and drinks that are high in sugar	10.1) Good advice from sustainability perspective 10.2) Not all sugar products are equally problematic from a sustainability perspective, and the issues are complex.
11. Choose water as a thirst quencher	11.1) Good advice from sustainability perspective
12. Be physically active for at least 30 minutes each day	12.1) Good advice from sustainability perspective
Look for keyhole when food shopping. [c]	
	13) Food waste: [d] Annual food waste from the food industry, wholesaler, grocery and household is 355,000 tones, equivalent to 1/4th of emissions from passenger car transport in Norway. Reducing food waste is among the UN's sustainability goals.
	14) Food packaging: [d] Usually food packaging is to reduce food waste, and therefore, it is not advised against it. However, a good recycling system is important.
	15) Local food: [d] Although the GHG emissions of food transportation has the lowest environmental impact (except air transportation), it is advised to consume Norwegian products from food security perspective.
	16) Breast feeding: [d] Is favorable from health and sustainability assessment.

Notes: [a] Dietary guidelines specified by the Norwegian Directorate of Health (Helsedirektoratet, 2015). [b] Sustainability recommendations provided by Øverby et al. (2017). [c] Keyhole is a voluntary Nordic label for food that compared to others of the same type, have either more dietary fiber, less saturated fat, less salt, or less sugar (Helsedirektoratet, 2015). No specific discussion of this item in Øverby et al. (2017). [d] Issues not mentioned in the Norwegian national dietary guidelines.

2. Literature Review

Sustainable dietary choices have mainly been studied by either investigating choices concerning one sustainable product or by investigating curtailment strategies of a product assumed to have a negative environmental impact (Verain, Dagevos, and Antonides, 2015), and the entire dietary patterns have rarely been investigated. Sustainable product choice usually refers to the choice of an organic, a local, an animal welfare, or a fair-trade product. Findings suggest that health-consciousness, concerns about environment and animal rights, perceived self-efficacy, trust in labeling and confidence in the information received about organic, fair trade, and animal welfare practices are among the factors affecting the choices of such sustainable products (Annunziata and Scarpato, 2014; Botonaki et al., 2006; Frewer et al., 2005; Honkanen, Verplanken, and Olsen, 2006; Vermeir and Verbeke, 2008). Curtailment strategies refer to limiting the consumption of food products with high and negative environmental impacts or less healthy foods such as red meat or energy dense and highly processed food. Willingness to reduce meat consumption, willingness to increase consumption of alternative meat substitutes, awareness of the contribution of meat to GHG emissions, self-efficacy and ethical concerns about animal slaughtering are among the factors determining curtailment strategies (Fox and Ward, 2008; Hartmann and Siegrist, 2017; Macdiarmid, Douglas, and Campbell, 2016; Pohjolainen et al., 2016). Studies have found that consumers differ in terms of their preference for different sustainable product choice or curtailment strategies, and whether they adopt a curtailment strategy or choose a sustainable product depends on food involvement, personal norms, knowledge, and sustainability motives (Tobler, Visschers, and Siegrist, 2011; Vanhonacker et al., 2013; Verain, Dagevos, and Antonides, 2015).

Personality is defined as: "relatively enduring patterns of thoughts, feelings, and behavior that reflect the tendency to respond in certain ways under certain circumstances" (Roberts, 2009: 140). One of the most widely accepted taxonomy of personality is the Big Five model, where openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (OCEAN) represent one's personality at "its broadest level of abstraction" (Pervin and John, 1999). Food-related research has shown that the OCEAN traits are associated with preferences for different types of food, dietary patterns, eating habits,

considerations of health consequences from food consumption, and several other aspects of consumers' food-related preferences and behavior (e.g., Ardebili and Rickertsen, 2020; Gustavsen and Hegnes, 2020; Gustavsen and Rickertsen, 2019; Nystrand, Olsen, and Tudoran, 2020; Weston, Edmonds, and Hill, 2020). In a sample of more than 13,000 Australian adults, Pfeiler and Egloff (2020) found three dietary patterns: carbohydrate-based, meat-based, and plant-based (including fish). They found that higher consumption of plant-based food was positively associated with openness and conscientiousness, higher consumption of meat was positively associated with extraversion and neuroticism and negatively with openness, and higher consumption of carbohydrates was positively associated with neuroticism and negatively with conscientiousness and extraversion. The associations of openness to experience and conscientiousness with healthier dietary patterns, and neuroticism and extraversion with unhealthier dietary patterns have also been confirmed in other studies (e.g., Keller and Siegrist, 2015; Mõttus et al., 2012; Tiainen et al., 2013). However, as discussed in Gustavsen and Hegnes (2020) association between personality traits and food choices does not explain the reasons behind the choices made, and such explanations can be obtained by investigating consumers' motivations and values.

Value may be defined as "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence" (Rokeach, 1973:5). A well-known value taxonomy was developed by Schwartz (1992), and the taxonomy was shown to be associated with consumers' behaviors and attitudes in several domains including the food domain. Examples include convenience of food consumption (Botonaki and Mattas, 2010), home meal preparation (Huynh and Olsen, 2015), consumption frequency of meat (Hayley, Zinkiewicz, and Hardiman, 2015), and sustainable food consumption (Vermeir and Verbeke, 2008). In consumer research, there is a consensus that individuals' values and beliefs shape their intentions to take or not to take an action, which ultimately form their behaviors, see for example Ajzen's (1985) theory of planned behavior. For example, studies found that ethical values such as concerns about environment or animal rights influence attitudes towards organic food (Honkanen, Verplanken, and Olsen, 2006), and that orientation towards convenience of the food is associated with perceptions about inconvenience of fish, which in return influence attitudes towards fish consumption (Olsen et al., 2007).

Motivated by Schwartz's value system and a review of the literature to identify food-related values that are likely to be stable across time, Lusk and Briggeman (2009) suggested a set of specific food values. These values were slightly revised by Bazzani et al. (2018) and include: safety, nutrition, naturalness, environmental impact, taste, appearance, convenience, animal welfare, origin, fairness, price, and novelty. These food values are assumed to indicate individuals' motivation for food choices, and several studies have found that they are important in determining preferences and demand for food products such as organic food (Bazzani et al., 2018; Lusk, 2011; Lusk and Briggeman, 2009); beef, chicken and milk (Lister et al., 2017; Tonsor, Lusk, and Schroeder, 2018); and willingness to pay for functional snack (Pappalardo and Lusk, 2016).

3. Methods

The data is from Norwegian Monitor Survey (NMS) and contains repeated cross-sectional data. NMS is a nationally representative survey and has been conducted every second year since 1985. It is one of the most comprehensive consumer surveys in Norway (Ipsos-MMI, 2016) and includes questions related to personality traits, food values, food preferences, eating habits, food intake, health-related behaviors, and several other life-style choices. Four sets of variables are of interest for this study: sociodemographic characteristics, food values, personality traits, and food intake from the food frequency questionnaire (FFQ). Personality traits and food values were not included in surveys prior to 2015, and data for this year is used. A total of 3,981 respondents participated in the survey in 2015, however, about 20% of the observations were deleted and final analysis was based on 3,210 respondents. Details concerning the deletion of observations are discussed in the next section.

3.1. Measures

Sociodemographic variables. Gender, education, marital status, and presence of children are measured using a set of dummy variables. The corresponding dummy variable is set to 1 if the respondent is male, have a university degree, is married or live with cohabitant, and have children younger than 15 years old in the household. Household's gross annual income

was initially measured in eleven categories, ranging from less than $10,470 to more than $209,400.[4] For each respondent, the income level was set to the midpoint of the specified interval, except for the highest and lowest categories where the censoring point was set as the income level. The log of household income for each respondent was then calculated to be used in the consequent analysis. For respondents with missing values (4%) income was replaced by the median income level, which was approximately $73,200.

Personality traits. A short version of the Big Five personality model developed by Engvik and Clausen (2011) was used to measure the personality traits. Table 2 presents the OCEAN traits, their definitions according to American Psychology Association (APA, 2007), and the 20 items suggested by Engvik and Clausen (2011) to measure the traits. Personality traits were measured by self-reported responses to these 20 items on a scale from 1 (the item does not describe the respondent at all) to 7 (the item describes the respondent very well). Each trait was constructed for each respondent by taking the mean values of the responses to the four associated items.[5]

Food values. Food values and their definition are presented in the Table 3, which is adopted from Bazzani et al. (2018). Each respondent was presented with the whole set of food values with the descriptions provided in paratheses, and were asked to choose the most and least important food values when purchasing food. Assuming that the food values are aligned on an underlying scale of importance, with this elicitation method one can only identify the two opposite ends of the scale, and no information can be inferred about the relative importance of the 10 other food values. To distinguish between these two extreme points of the underlying scale of importance, responses were effect coded. In particular, each food value was set to 1 if it was chosen as the most important, -1 if it was chosen as the least important, and 0 if it was not chosen.

Food Frequency Questionnaire (FFQ). The FFQ in NMS contains questions about the consumption frequency of 387 different food items. The items are popular dishes, ethnic foods, salads, soups, sauces, meat, fish, egg and dairy, rice, pasta, cereals, legumes, fruits, vegetables, sweets, alcoholic and non-alcoholic beverages. Several of these food items are

[4] Converted using the exchange rate 1 NOK = 0.1047 USD, which was the average rate in June 2020.
[5] The scores of negative worded items were reversed.

included in different forms, such as fresh, frozen, packaged, cut, whole, etc. Consumption frequencies of the food items in the FFQ were recorded based on 8-point scale and these frequencies were converted to the number of servings per week.[6] Categories were (converted to servings per week) 1 = Every day (7 times/week), 2 = 3 to 5 times per week (4 times/week), 3 = 1 to 2 times per week (1.5 times/week), 4 = 2 to 3 times per month (0.625 times/week), 5 = once per month (0.25 times/week), 6 = 3 to 11 times per year (0.146 times/week), 7 = rarely (0.03 times/week), 8 = never (0 times/week).

Table 2. The OCEAN traits

Trait	APA definition [a]	Items [b]
Openness to experience	The tendency to be open to new aesthetic, cultural, or intellectual experiences	• Original with new ideas • Lively imagination • Likes to speculate and play with ideas • Few artistic interests
Conscientiousness	The tendency to be organized, responsible, and hardworking	• Do a thorough job • Careless • Usually have a messy life • Make plans and follow them up
Extraversion	An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience	• Talkative • Tends to be quiet • Shy • Outgoing and social
Agreeableness	The tendency to act in a cooperative, unselfish manner	• Helpful and selfless towards others • Can be cold and aloof • Considerate and friendly to most people • May sometimes be rude
Neuroticism	A chronic level of emotional instability and proneness to psychological distress	• Depressed • Relaxed, cope well with stress • Worries too much • Gets nervous easily

Source: The table is identical to Table 1 in Ardebili and Rickertsen (2020) who adopted the table from Almlund et al. (2011).
Notes: [a] Definitions according to American Psychology Association's (APA) dictionary of psychology (APA, 2007). [b] Items are adjusted based on BFI-20 developed by Engvik and Clausen (2011).

[6] One month is considered to have four weeks, and a year is considered to have 12 months. For the interval-scaled categories, the midpoint is used.

Table 3. Food values

Food value	Description
Naturalness	Made without modern food technologies like genetic engineering, hormone treatment and food irradiation
Safety	Eating the food will not make you sick
Environmental impact	Effects of food production on the environment
Origin	Whether the food is produced locally, in the US/Norway or abroad
Fairness	Farmers, processors and retailers get a fair share of the price
Nutrition	Amount and type of fat, protein, etc.
Taste	The flavor of the food in your mouth
Appearance	The food looks appealing and appetizing
Convenience	How easy and fast the food is to cook and eat
Price	Price you pay for the food
Animal welfare	Well-being of farm animals
Novelty	The food is something new that you have not tried before

Source: The food values and their definition are adopted from Table 2 in Bazzani et al. (2018).

Deleted observations. About 20% of the observations were deleted from the original sample which included 3,981 observations. Respondents older than 80 years old were excluded (71 observations) due to possible health conditions that were likely to affect their dietary pattern. Respondents younger than 18 years old were excluded (137 observations) since they might not be fully responsible for their food consumption. Respondents who had missing values on all the items associated with one or more of the OCEAN traits were excluded (50 observations). Respondents who chose more than one food value as the most and/or least important, or chose the same food value as most and least important, or did not choose any of the food values were excluded (496 observations). Following Khani et al. (2004) and Hansson and Galanti, (2000), missing values on food items of FFQ were replaced by zero consumption, and respondents who had missing values for more than half of the food items in FFQ were excluded (17 observations). The remaining sample consists of 3,210 respondents.

3.2. Statistical models

Principal component analysis (PCA) was used as a data driven approach to detect existing dietary patterns among the Norwegians. PCA is a data reduction technique and is widely used in nutrition research to derive dietary patterns from FFQ (e.g., Khani et al., 2004; Korkalo et al., 2019; Mõttus et al, 2012; 2013; Niedzwiedzka, Wadolowska, and Kowalkowska, 2019; Pfeiler, and Egloff, 2020). The objective of PCA is to generate a set of linear combinations of the observed variables that have maximum variance to reduce the number of observed variables to a subset of principal components or factors (Wang et al., 2013).[7]

The FFQ in NMS includes 387 food items. For some foods, first a general question was asked about consumption frequency of all types of that food category, for example all types of fruits or vegetables, followed by several detailed questions such as apple, orange, etc. Prior to conducting the PCA, items referring to all types of one food category were excluded (8 items). All alcoholic beverages were also excluded to keep the main concern of the study on individuals' eating behavior (24 items).[8] Finally, food items from which a majority of the sample (more than 90%) consumed very little of (less than once a month) were excluded (40 items). The remaining 315 food items were tested by Bartlett test of sphericity, which tests the presence of sufficient intercorrelations among the variables. The test rejected the null hypothesis of no intercorrelation among the variables (p-value = 0.00). Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, which quantifies the degree of intercorrelations among the variables, was also calculated. KMO was 0.86, which indicates suitable intercorrelation to employ PCA (Hair et al., 2014:102).

A PCA of the 315 food items suggested three predominant factors among the food items. The eigenvalues of the first six factors were 15.59, 12.48, 9.59, 4.33, 4.17, 3.72, and the scree plot of the eigenvalues suggested retaining three to four factors. The fourth factor did not substantially increase the total variance explained among the variables and therefore three factors were retained. Several rounds of PCA were conducted before the final solution

[7] The terms 'principal components', 'principal component factors' and 'factors' are used interchangeably in the literature. We use the term 'factors' for sake of simplicity. The mathematical specification of the PCA is provided in the Appendix.

[8] It is worth mentioning that studies have shown that high alcohol consumption is associated with unhealthier dietary patterns (see for e.g., Fawehinmi et al., 2012; Scott et al., 2020), and such behavioral patterns are also associated with several other factors such as impulsive behaviors, binge eating, emotional eating, etc. which are not being considered in this study.

emerged. At each round, a PCA that was restricted to retain three factors was estimated. For better interpretability, the factors were rotated using an orthogonal varimax rotation. The resulting model was then investigated and food items with low rotated factor loadings for all factors ($< |0.3|$) or cross loadings (two or three factor loadings $> |0.3|$) were excluded from the model.[9] The process repeated until no cross loadings or low factor loadings remained. In total, 202 items were excluded due to low factor loadings, and 8 items were excluded due to cross loadings, and the final three factor solution was based on 105 food items.[10]

The factors in PCA represent the three predominant dietary patterns in the sample. For each respondent, factor scores of the three dietary patterns were predicted from the PCA using regression method.[11&12] These scores were used as the dependent variable in the subsequent OLS regressions. In the OLS regressions, the predicted scores for dietary patterns were specified to be a function of sociodemographic variables, OCEAN traits, and food values.

4. Results

Table 4 presents the summary statistics of the sociodemographic variables. The average respondent was 46 years old, and about half the sample was female. Around 60% of the respondents had a university degree, 65% were married or lived with their cohabitant, and 31% were living with one or more children aged below 15 years of age.

[9] According to Hair et al. (2014:116), factor loadings above |0.5| are considered of practical significance, however, for large samples loadings above |0.3| can be considered minimally acceptable. Food item was retained if cross loadings was due to two high factor loadings with apposite signs.

[10] It is worth mentioning that among the 105 food items in the final model, several items are double counted, which can result in overestimation of their consumption frequencies. For example, meat, vegetables, or spaghetti may also be included in pizza, Italian food, and so on. These items were not excluded because investigating the underlying consumption patterns is of main interest for this study, about which these food items provide useful information.

[11] These scores represent a weighted linear combination of the items, where weights are determined by the factor loadings obtained from the PCA. The specification of regression method to predict the scores is provided in the Appendix. These scores are standardized; zero mean and unit standard deviation.

[12] Other studies have also used the predicted scores from PCA of FFQ to investigate factors influencing individuals' dietary patterns, such as the role of food environment, proximity to food sources, diet knowledge (e.g., Mercille et al., 2012; 2016), or personality traits (Pfeiler and Egloff, 2020).

Table 5 presents the mean and standard deviation (second column), Cronbach's alpha reliability coefficients in the sample and in the parentheses as reported by Engvik and Clausen (2011) (third column), and the correlation matrix of the constructed OCEAN traits (the last five columns). Respondents on average consider themselves to be high on conscientiousness and agreeableness, and low on neuroticism. Cronbach's alpha values represent scale reliability coefficients from the standardized items used to construct the personality traits, and values above 0.6 suggest construct reliability (Hair et al., 2014: 619). Alpha values are below 0.6 for conscientiousness and agreeableness, but they are close to the values reported by Engvik and Clausen (2011). Finally, the correlation matrix of the OCEAN traits indicates that several correlations are significant, but none is above |0.34|.

Table 4. Summary statistics of the sociodemographic variables [a]

Variable	Description	Mean	SD
Age	Age in years	46.75	17.55
Gross annual Income [b]	Log of household income	6.49	0.65
Gender	1 = if male	0.48	0.50
Education	1 = if has a university degree	0.59	0.49
Marital status	1 = if married or cohabitant	0.65	0.48
Children	1 = if live with children below 15 years old	0.31	0.46

Notes: [a] Based on 3,210 respondents. [b] Income was initially measured in interval categories ranging from less than $10,470 to more than $209,400. Each respondent's income was set to the midpoint of the income group, and the log of this income was used in the analysis. For the highest and lowest income groups, the censoring point was set as the income, and observations with missing income were categorized in the median income category; between $62,820 – $83,655, converted using the exchange rate 1 NOK = 0.1047 USD, which was the average rate in June 2020.

Table 6 presents the mean values (in descending order) and standard deviations of the effect coded food values. The scores assigned to the food values range from -1 to 1, sum to zero across all food values since everyone included in the sample had picked one food value as the most important and one as the least important. The results indicate that taste and safety are the most important food values, while novelty and convenience are the least important food values in this sample. Following Lusk and Briggeman (2009), we will refer to these scores as the 'importance score' of each food value.

Table 5. Descriptive statistics, scale reliability, and the correlation matrix of the OCEAN traits [a]

			Correlation matrix [d]				
	Mean [b]	α [c]	O	C	E	A	N
Openness to experience	4.27 (1.22)	0.68 (0.63)	1.00				
Conscientiousness	5.23 (0.93)	0.54 (0.57)	-0.07*	1.00			
Extraversion	4.76 (1.30)	0.80 (0.78)	0.11*	0.12*	1.00		
Agreeableness	5.46 (0.91)	0.58 (0.63)	-0.01	0.34*	0.25*	1.00	
Neuroticism	3.11 (1.26)	0.75 (0.73)	0.02	-0.20*	-0.29*	-0.20*	1.00

Notes: [a] Based on 3,210 respondents. [b] Mean values with standard deviations in the parentheses for the constructed traits. [c] Cronbach's alpha values represent scale reliability coefficients from the standardized items. The values in the paratheses are Cronbach's alpha values as reported by the developers of the BFI-20 (Engvik and Clausen, 2011). [d] Correlation matrix of the constructed traits. An asterisk indicates significance at the 5% significance level.

Table 6. Food values

Food value	Mean	SD
Taste	0.25	0.44
Safety	0.12	0.38
Nutrition	0.11	0.36
Animal welfare	0.04	0.33
Naturalness	0.04	0.35
Price	0.01	0.40
Appearance	-0.01	0.33
Environmental impact	-0.04	0.27
Fairness	-0.04	0.36
Origin	-0.04	0.45
Convenience	-0.06	0.36
Novelty	-0.39	0.49
Sum	0.00	

Note: Mean and standard deviation of the importance scores ranging from -1 to 1, based on 3,210 observations.

The results of the orthogonally rotated three-factor model obtained from PCA based on 105 food items are summarized in Table 7 and Figure 1.[13] Table 7 lists the bundles of food

[13] The full estimation results of the model are provided in Table A1 in Appendix. In addition, the analysis was carried out using nonorthogonal rotations, and the results were very similar. The correlation between the predicted score after orthogonal and non-orthogonal rotations was above 0.95 for all factors.

items that had rotated factor loadings above |0.3| for each dietary pattern. The first column lists the food items with high factor loadings on the first factor, the second column lists the food items with high factor loadings on the second factor, and the last two columns list the food items with high factor loadings on the third factor. For each dietary pattern, food items are sorted from largest to smallest factor loading. For example, the loading of the fresh salad on the sustainable diet is larger than loadings of all other items on the sustainable diet. The proportion of the variance explained by each factor is reported in the last row of the table. The three factors together explain around 21% of the total variance among 105 food items.[14] The factors represent the underlying structure of the dietary patterns among the respondents, and these factors will be referred to as diets or dietary patterns. Each dietary pattern was given a name that can reflect the sustainability recommendations in Table 1 and are discussed in more details below: sustainable, traditional, and unsustainable. Figure 1 illustrates the scatter plots of the factor loadings on the three dietary patterns and is discussed below. The results of the PCA will be described using Table 7 and Figure 1.

The sustainable diet (first column, Table 7) explains about 8% of the total variance among the 105 food items and consists of 34 items with high factor loadings. Some of the 34 food items include several fresh fruits and vegetables, beans, oatmeal, vegetable oils, and some dairy products. According to Table 1, a sustainable food consumption pattern includes consumption of a variety of fruits and vegetables and whole grain foods (advices 3.1 and 4.1), includes rapeseed or olive oil rather than palm oil (advices 8.1 and 8.2), and limits the consumption of red and processed meats (advices 6.1 to 6.5). This dietary pattern seems to be compatible with several sustainability recommendations and is given the name sustainable.

The traditional dietary pattern (second column, Table 7) explains 5% of the total variance among the 105 food items and consists of 25 items with high factor loadings. Some of the 25 food items include traditional Norwegian dishes, meatballs, beef patties, or oven baked pork/lamb/beef, several dishes including fish, root vegetables and vegetable stew,

[14] According to Hair et al. (2014:107), in social science where information is less precise, it is common to consider solutions with 60% or even less share of the variance explained. The share of explained variance is similar to other studies who used PCA for FFQ (e.g., Hamer et al., 2010; Korkalo et al., 2019; Mõttus et al., 2012, 2013; Niedzwiedzka et al., 2019).

Table 7. The dietary patterns obtained from PCA on 105 food items

Sustainable [a]	Traditional [a]	Unsustainable [a]	
1. Fresh salad	1. Cooked potato	1. American dish	26. Minced meat, lean
2. Garlic	2. Meatballs	2. Taco sauce in glass	27. Wraps
3. Onion	3. Potato	3. Mexican dish	28. Chips, low fat
4. Bell pepper	4. Beef patties	4. Hamburger	29. Sprite, original
5. Fresh spice plants	5. Pollock fillet	5. Italian dish	30. Minced pork
6. Olive oil	6. Fish gratin/ pai	6. Minced meat	31. Hotdog bread
7. Raw vegetables	7. Flat bread	7. Frozen pizza	32. Bakeries from convenient store
8. Tomatoes	8. Lam/pork/beef baked in oven	8. French fries	33. Snacks from convenient stores
9. Avocado	9. Fish pudding	9. Dry pasta	34. Fresh pasta
10. Cucumber	10. Traditional Norwegian dish	10. Lasagna	35. Energy drinks
11. Balsamic dressing	11. Fish balls	11. Homemade spaghetti	36. Beef
12. Fried vegetables	12. Rice pudding	12. Homemade pizza	37. Ice tea
13. Rapeseed oil	13. Potato pudding in bag	13. Pizza bun	38. Ready sauce in box/bag
14. Rocket salad	14. Sour cabbage	14. Grill sausage	39. Cake from mix
15. Squash/eggplant	15. Homemade cake	15. Spaghetti ready from store	40. Ketchup
16. Vegetarian dish/soup/pai	16. Pork chops	16. Stew, ready from bag/box	41. Hotdogs
17. Parmesan or mozzarella cheese	17. Fish cake	17. Snack food, e.g., noodles, soup in cup	42. Ready meals, deep frozen
18. Homemade	18. Homemade jam	18. Noodles	43. Hermetic meals
19. Fresh fruit for dessert	19. Waffle	19. Shredded cheese for pizza	44. Ice coffee
20. Soya oil	20. Vegetable stew	20. Candy from the shelf	45. Milkshake or smoothie
21. Mushroom	21. Homemade bakery	21. Maize	46. Coca cola, original
22. Apple	22. Aged yellow/ white cheese	22. Snacks from gas station	
23. Mango	23. Pollock	23. Warm cheese sandwich	
24. Melon	24. Root vegetables	24. Chips	
25. Asparagus	25. Potato bread (lefse)	25. Packaged candy	
26. Beans			
27. Natural yoghurt			
28. French dishes			
29. Oatmeal			
30. Raspberry			
31. Crème fraiche			
32. Wok			
33. Blueberry			
34. Banana			
8% [b]	5% [b]	8% [b]	

Notes: [a] Dietary patterns obtained from the PCA of 105 food items. Based 3,210 observations. For each dietary pattern, food items with rotated factor loadings above |0.3| on the associated dietary pattern are listed, and sorted in descending order of the loadings' magnitude. The full estimation result is available in Table A1 in the Appendix. [b] Percentage of the total variance in the 105 food items explained by the dietary pattern.

potato bread or flat bread, and homemade items such as jam and cake. Several of these food items are typical and traditional Norwegian dishes, and the pattern is given the name traditional. The traditional diet also corresponds well with some of the sustainability advices in Table 1. For example, a certain consumption and production of red meat is necessary to utilize the Norwegian land resources, however, beef is recommended to be avoided (advices 6.1 to 6.5). Consumption of minced meat also allows the use of parts of the animal that are not easily sold as unprocessed meat. The traditional diet is also associated with consumption of vegetables (such as potato, rutabaga, vegetable stew). It is also high in the consumption of fish, which has lower carbon footprint than other animal products (advices 5.1 and 5.2).[15] The food items with high loadings in this dietary pattern include more fish, vegetables, and grains than meat, and we consider it to be somewhat sustainable in the Norwegian context.

The unsustainable dietary pattern (last two columns, Table 7) explains 8% of the variance among the 105 food items and consists of 46 food items with high factor loadings. The diet is associated with high consumption of beef, minced beef, minced pork, hotdogs and grilled sausages. Moreover, several dishes that typically include meat such as pizza, burger, spaghetti, lasagna, Mexican food, and several ready meals such as frozen pizza, readymade spaghetti from store, deep-frozen or hermetic ready meals are parts of this diet. Finally, the diet is associated with consumption of refined grains, sugary snacks, and sugary drinks. The food items in this diet are inconsistent with a healthy diet and incompatible with the majority of the sustainability advices described in Table 1, and the pattern is given the name unsustainable. Moreover, a high consumption of several ready meals or drinks are associated with excess packaging. Øverby et al. (2017) discuss how packaging usually reduces the food waste, and do not give any specific advice against it (see advice 14). However, large consumption of ready meals or sugary drinks will introduce more packaging as compared with preparing the same meals at home or drinking water.

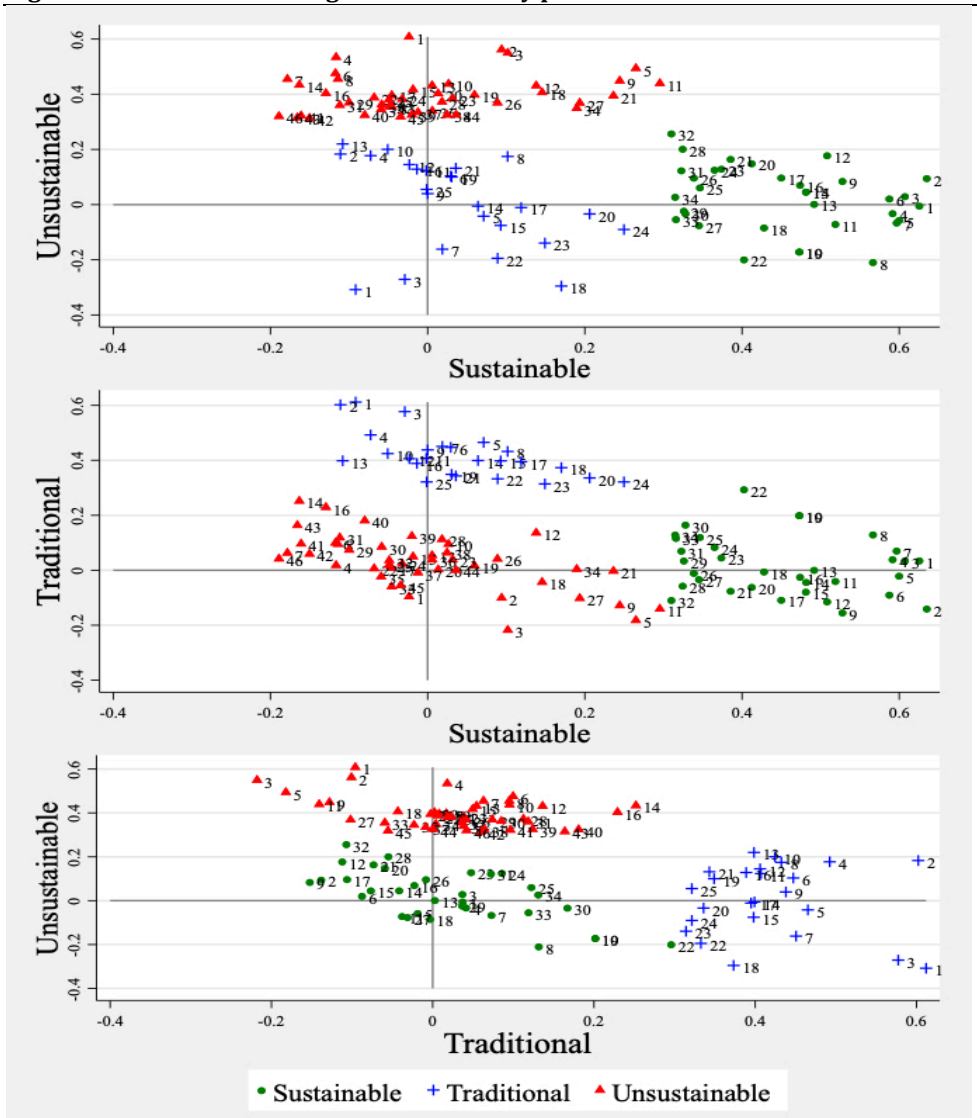
The loadings of the food items on the dietary patterns are presented in Figure 1. The panels plot the loadings on the unsustainable versus the sustainable diet (first), the

[15] Given the available data, it is not possible to verify whether the fishes consumed were from sustainable sources, i.e., harvested from unexploited stock and/or from sustainably managed fish farms. However, several Norwegian fisheries and aquaculture are considered among the most sustainable practices in the world (Norwegian Seafood Council, 2020a; 2020b).

traditional versus sustainable diet (second), and the unsustainable versus the traditional diet (third). The green circles, blue plus marks, and red triangles represent the items with high loadings on the sustainable, traditional and the unsustainable diet, respectively. Label of the markers in the figure corresponds to number of food items for each dietary pattern in Table 7. These plots demonstrate how strongly each food item is associated with the dietary pattern. For example, fresh salad (green circle marked as 1) has the strongest associations with the sustainable diet; American dish (red triangle marked as 1) has the strongest association with the unsustainable diet; and cooked potato (blue plus marked as 1) has the strongest association with the traditional diet. Another observation that can be made from these plots is the extent to which the dietary patterns are distinct from one another. In each plot food items are gathered in three relatively separated bundles of food items represented by the green, blue and red markers. The last panel demonstrates the distinctiveness of the three dietary patterns most clearly.

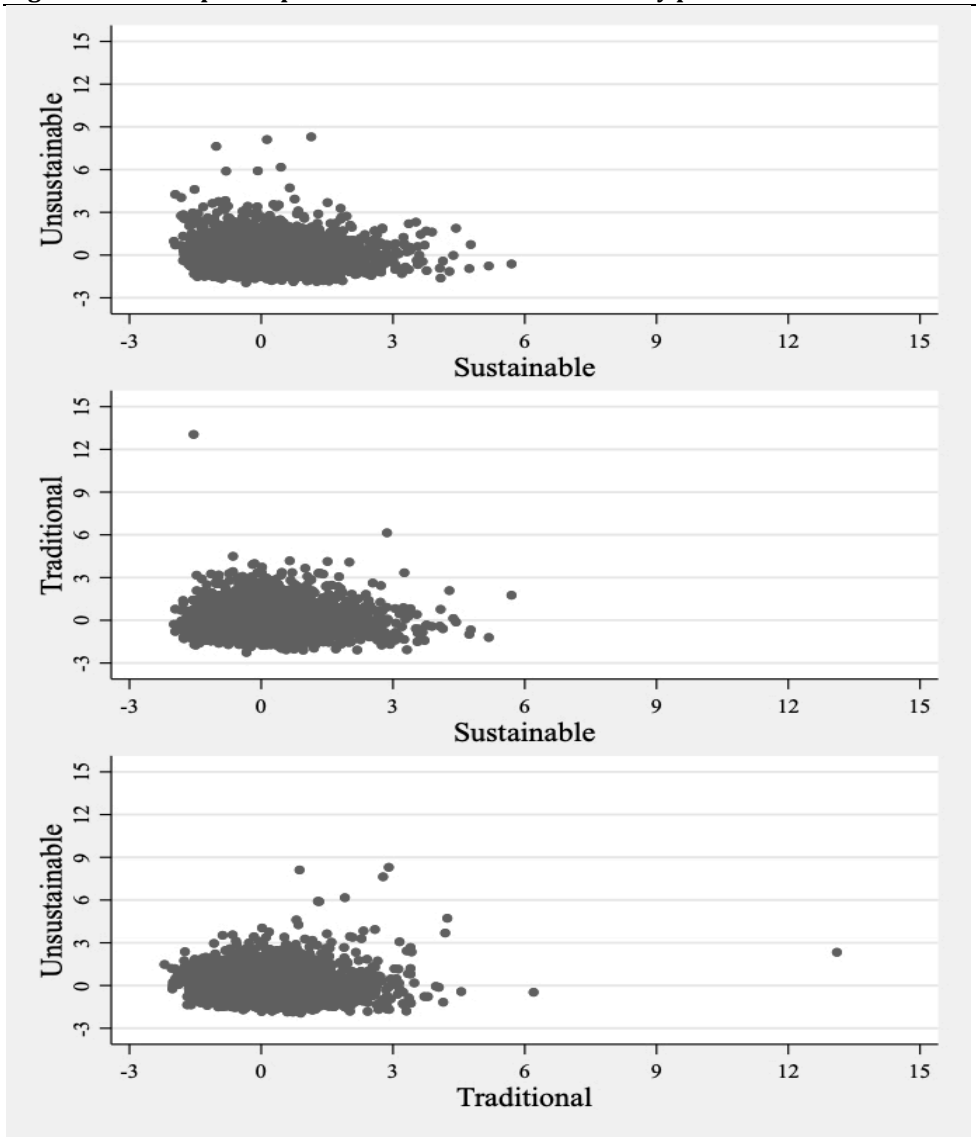
The factor scores were predicted for each respondent and dietary pattern using regression method. Figure 2 illustrates the scatterplot of the predicted scores and the axes represent the predicted score of the associated dietary pattern. These scores are standardized with zero mean and unit standard deviation. The panels plot the predicted scores of the unsustainable versus the sustainable diet (first), the traditional versus sustainable diet (second), and the unsustainable versus the traditional diet (third). As illustrated by the panels, predicted scores of each dietary pattern in the sample are distributed around zero and range approximately between -3 to 6 for majority of the observations. However, two observations for the traditional and four for the unsustainable diet seem to have substantially higher values than the rest of the observations and can be considered as outliers. We removed these observations to avoid possible disruption of the OLS regression analyses below.

Figure 1. Food items' loadings on each dietary pattern



Notes: Label of the markers in the figure corresponds to number of food items for each dietary pattern in Table 7.

Figure 2. Scatter plot of predicted scores for three dietary patterns



Notes: The predicted values of the factor scores for each individual and dietary pattern. Based on 3,210 observations.

The predicted scores for each diet were used as a dependent variable in a set of OLS regressions to investigate the role of food values, personality traits and sociodemographic factors on the adopted dietary patterns. In Table 8, estimated coefficients with the associated standard errors in the parentheses are reported for three models for each dietary pattern. Model 1 includes only sociodemographic variables and the results are in the columns labelled 1. Model 2 includes sociodemographic variables and the OCEAN traits and the results are in the columns labelled 2. Model 3 includes sociodemographic variables, the OCEAN traits, and food values, and the results are in the columns labelled 3. The last row reports the R-squared values. A dagger (†) indicates significance of a Wald test for joint significance of the variables added to the Model (2) as compared with the Model (1), and Model (3) as compared with the Model (2). In all the models, dietary patterns and OCEAN traits are standardized and measured in standard deviation (SD). Therefore, the marginal effects of the explanatory variables can be interpreted as SD change in the score of the associated dietary pattern. The sum of the importance scores of the 12 food values is zero by construction, and one food value must be excluded to avoid perfect multicollinearity. The food value "environmental impact" is excluded because it is expected to be an important factor to adopt a sustainable consumption pattern. Given this normalization, a positive food value suggests that it is more important motivation than environmental impact in adopting the dietary pattern.

The R-squared values indicate that sociodemographic factors explain most of the variance in the dietary patterns. However, the Wald tests indicate significance of personality traits and food values. The results of Model 2 and Model 3 also suggest that the effects of the personality traits change after the inclusion of food values. For example, extraversion is positively associated with the sustainable diet in Model 2, but became insignificant after food values were accounted for. The results are discussed in more detail in the context of Model 3.

According to the R-squared value, 19% of the variance of the sustainable diet is explained by the explanatory variables. The average score of the sustainable dietary pattern is positively associated with income, and is higher among women, those who have higher education, or are married. Openness to experience and conscientiousness are positively associated with the sustainable diet. One SD increase in the scores of openness to experience

is associated with 0.14 SD increase in the score of the sustainable dietary pattern, which is the largest marginal effect among the OCEAN traits for any dietary pattern. The negative significant coefficients of animal welfare, fairness, origin, convenience, appearance, safety, novelty, price, and taste imply lower importance of these food values relative to the environmental impact, as motivations to adopt the sustainable diet. The negative marginal effects of the food values range from -0.19 to -0.57 SD, and convenience and price have the largest marginal effects on this diet. A one unit increase in the importance scores of convenience and price (e.g., from 0 to 1) decreases the score of the sustainable diet by 0.57 and 0.41 SD, respectively.

According to the R-squared value, 23% percent of the variance of the traditional diet is explained by the explanatory variables. Age is associated with a higher score of the traditional diet, and the average score of this diet is higher among men, respondents with lower education level, with children, and married respondents. Openness to experience is negatively and extraversion and agreeableness are positively associated with the traditional diet. With a coefficient of 0.06, agreeableness is the trait with the largest marginal effect on the traditional dietary pattern. Fairness, origin, convenience, safety, and novelty are more important motivations than environmental impact for adopting the traditional diet. The marginal effects of the food values range between 0.13 to 0.34, and origin and fairness have the largest marginal effects. A one unit increase in the importance score of origin and fairness increase the score of the traditional diet by 0.34 and 0.26 SD, respectively.

According to the R-squared value, 46% percent of the variance of the unsustainable diet is explained by the explanatory variables. Age is negatively and income is positively associated with the score of this diet. The average score of the unsustainable diet is higher among men, among those who are married, or have children. Conscientiousness is negatively and extraversion and neuroticism are positively associated with this dietary pattern. With a coefficient of 0.07, extraversion is the trait with the largest marginal effect on the unsustainable dietary pattern. Convenience, appearance, safety, novelty, taste, and price are positively associated with the unsustainable diet, which indicate these food values are more important motivations than the environmental impact to adopt the unsustainable diet. The marginal effects of the food values range from 0.14 SD to 0.25 SD, with price and convenience having the largest effects.

Table 8. Parameter estimates with standard errors in parentheses [a]

	Sustainable [b]			Traditional [b]			Unsustainable [b]		
	1	2	3	1	2	3	1	2	3
Age	-0.00*	-0.00	-0.00*	0.02*	0.02*	0.02*	-0.03*	-0.03*	-0.03*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Income	0.13*	0.13*	0.12*	0.00	0.01	0.02	0.05	0.06*	0.07*
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
Gender	-0.47*	-0.46*	-0.42*	0.14*	0.17*	0.18*	0.27*	0.30*	0.26*
	(0.03)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Education	0.39*	0.34*	0.33*	-0.29*	-0.27*	-0.26*	-0.06*	-0.05	-0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Marital status	0.09*	0.09*	0.10*	0.16*	0.15*	0.14*	0.11*	0.10*	0.10*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)
Children	0.02	0.04	0.02	0.17*	0.16*	0.15*	0.24*	0.24*	0.24*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Openness to		0.16*	0.14*		-0.04*	-0.03*		-0.00	0.02
experiences		(0.02)	(0.02)		(0.02)	(0.02)		(0.01)	(0.01)
Conscientiousness		0.06*	0.05*		-0.03	-0.03		-0.03*	-0.03*
		(0.02)	(0.02)		(0.02)	(0.02)		(0.01)	(0.01)
Extraversion		0.04*	0.04		0.03	0.03*		0.08*	0.07*
		(0.02)	(0.02)		(0.02)	(0.02)		(0.01)	(0.01)
Agreeableness		0.01	0.00		0.06*	0.06*		-0.01	-0.01
		(0.02)	(0.02)		(0.02)	(0.02)		(0.01)	(0.01)
Neuroticism		0.00	0.01		0.01	0.02		0.07*	0.06*
		(0.02)	(0.02)		(0.02)	(0.02)		(0.01)	(0.01)
Nutrition			-0.03			-0.01			-0.03
			(0.08)			(0.07)			(0.06)
Naturalness			-0.13			0.12			0.02
			(0.08)			(0.07)			(0.07)
Animal welfare			-0.25*			0.10			0.05
			(0.08)			(0.07)			(0.06)
Fairness			-0.19*			0.26*			0.05
			(0.07)			(0.07)			(0.06)
Origin			-0.30*			0.34*			0.07
			(0.06)			(0.06)			(0.06)
Convenience			-0.57*			0.13*			0.22*
			(0.07)			(0.07)			(0.06)
Appearance			-0.33*			0.11			0.13*
			(0.07)			(0.07)			(0.06)
Safety			-0.28*			0.16*			0.17*
			(0.07)			(0.07)			(0.06)
Novelty			-0.20*			0.16*			0.22*
			(0.06)			(0.06)			(0.05)
Price			-0.40*			0.08			0.25*
			(0.07)			(0.07)			(0.06)
Taste			-0.32*			0.00			0.18*
			(0.07)			(0.06)			(0.06)
R^2 [c]	0.12	0.15†	0.19†	0.20	0.21†	0.23†	0.43	0.44†	0.46†

Notes: [a] OLS regressions using 3,204 observations. Six observations were removed due to outliers. [b] Columns labelled 1 report the results of OLS regression of the associated dietary pattern on sociodemographic variables.

Columns labelled 2 report the results of OLS regression of the associated dietary pattern on sociodemographic variables and the OCEAN traits. Columns labelled 3 report the results of OLS regression of the associated dietary pattern on sociodemographic variables, the OCEAN traits, and food values. Heteroscedasticity robust standard errors in parentheses. [c] † indicates joint significance of the additional variables from a Wald test at the 5% significance level.

5. Discussion, Implications and Limitations

The most influential personality trait in predicting individuals' dietary pattern was openness to experience. Openness to experience was positively associated with the sustainable diet, and its marginal effect was largest among the personality traits across all models. Similar associations between this trait and healthier diets and consumption frequency of fruits and vegetable are in line with previous results (Mõttus et al., 2012; Pfeiler and Egloff, 2018; 2020; Sutin and Terracciano, 2016). Openness was also negatively associated with the traditional diet, indicating that those who are open to experiences have lower score of the traditional diet. The results indicate that a certain level of openness to experience is necessary for consumers to be willing to try new food items, and associations between openness to experience and dietary patterns that are high in the consumption of fruits and vegetables indicate the importance of familiarity with the consumed food items (Mõttus et al., 2012).

Food values in general had stronger associations with the dietary patterns than the personality traits. This finding is similar to Huynh and Olsen (2015) who found that the influence of personal values on attitudes towards home meal preparation is stronger than personality traits. Several food values were negatively associated with the sustainable diet. Given normalization of the environmental impact, the findings indicate that prevalence of the sustainable diet is primarily due to concerns about the environmental impact of food consumption. Other aspects of sustainability (such as fairness, animal welfare, and origin) or aspects mainly related to personal gains (such as convenience, price, appearance, taste, novelty, and safety) seem to be less important motivations than environmental impact in adopting a sustainable consumption pattern. Respondents who adopt the traditional diet seem to primarily be concerned with other aspects that potentially are associated with sustainability, such as local production and protection of farmers, than the environmental impact.

The differences in motivations behind the sustainable and traditional diets resemble the public debates concerning sustainable meat consumption in Norway. Through a content analysis of five Norwegian newspapers from 2000 to 2010, Austgulen (2014) found two opposite sets of opinions in the public debates. On one side was the environmental organizations, who argued against grazing animals and locally produced meat in favor of reducing meat consumption. On the other side was the agricultural organizations, who argued for production and consumption of Norwegian meat. This lack of consensus may not only lead to consumers' confusion but also to reduced willingness to engage in food-related sustainability practices (Austgulen, 2014). Our findings indicate that this divergence of opinions is reflected in consumers' behavior as well. One consumption pattern aims to reduce the environmental impacts by almost eliminating the consumption of meat, while the other pattern aims to protect farmers and local production with some consumption of red meat.

Other factors are also important in determining individuals' food consumption patterns. Convenience has the largest negative marginal effect and can be considered to be the most important barrier towards adopting a sustainable diet. This food value is also influential in adopting the unsustainable and traditional diets. This finding is interesting as convenience was ranked among the least important food values among the respondents and in previous findings as well (e.g., Bazzani et al., 2018). Lusk (2011) discussed how food values can be interpreted as consumers' perceptions about the food items. Our results indicate that respondents associated consumption of several fruits and vegetables with complicated and time-consuming food preparation processes. Due to this perceived lack of convenience, they are reluctant to frequently consume such items.

The trade-off between price and taste and environmental impact is important in explaining the adopted dietary patterns. Our respondents perceived the unsustainable dietary pattern to be cheap and tasty, while the sustainable diet was considered to be less satisfactory in taste and price. Lower importance of novelty, safety, and appearance as compared with environmental impact in the sustainable diet indicate that consumers may perceive the sustainable dietary pattern to be less appealing, limited in options to try new food, and rather surprisingly to be less safe. The opposite seems to be true for the traditional and unsustainable diets.

These findings may contribute to the 'what', 'who', and 'why' aspects of individuals' food consumption behavior. The prevalent dietary patterns among the consumers may inform us about 'what' people eat, the associated personality traits may inform us about 'who' adopt such consumption patterns, and the associated food values may inform us about 'why' such consumption patterns are adopted. This information has several practical implications.

Knowing what people eat helps identifying food items to be substituted by more sustainable alternatives. For example, two of the dietary patterns were associated with consumption of red meat. Previous studies found that in a Norwegian context production of meat from suckler cows has higher environmental impacts than from dairy cows or lamb (Oort and Andrew, 2016; Øverby et al., 2017). Appropriate information on the more sustainable substitutes may have a larger impact on the diet of meat eaters rather than suggesting eliminating consumption of red meat all together. Moreover, the unsustainable dietary pattern indicated consumption of several ready meals and prepared food items. As pointed by Hoek et al. (2017), there will always be some individuals who would prefer the convenient option. Therefore, attempts to regulate ready meals sold in the stores to include sustainable ingredients or packaging can be an alternative to reduce the environmental impacts of the unsustainable diet.

Knowing who adopts a certain diet helps identifying the target consumers. Studies found that personality-targeted interventions effectively improved problem drinking behavior (e.g., Conrod, Castellanos-Ryan, and Mackie, 2011; O'Leary-Barrett et al., 2016), and personality-targeted marketing positively affected attitudes, intentions, and actual purchase of consumer products (e.g., Hirsh, Kang, and Bodenhausen, 2012; Matz et al., 2017). The findings in this paper indicated that extraversion and neuroticism were associated with a higher score on the unsustainable diet, and lower score of openness to experience was associated with lower score of the sustainable diet. To effectively encourage extroverted and neurotic individuals to consume more sustainable substitutes, or less open individuals to consume more of fruits and vegetables, persuasion strategies can be tailored according to individuals' personality. Personality traits can be predicted through individuals' online behavior on websites, Facebook, Twitter, or other platforms (e.g., Bachrach et al., 2012; Golbeck et al., 2011; Marcus, Machilek, and Schütz, 2006; Tadesse et al., 2018). Therefore,

personality-targeted strategies are becoming an increasingly achievable goal, especially given the growth in digital footprint of the population. Furthermore, low scores on openness suggest that it is more difficult to adopt to changes and in particular consume food items that are unheard of. This suggests attempt to increase perceived familiarity of fruits and vegetables can be effective in increasing consumption frequencies of these food items.

Knowing why a diet is(not) adopted provides guidance on how to influence consumers' behavior given their perceptions. For example, convenience is a barrier towards consumption of several fruits and vegetables, and an important factor to consume several processed meats and ready meals. To convince more people to consume more of fruits and vegetables, and in particular new types of fruits and vegetables, it is important to educate and familiarize consumers on how to integrate a variety of fruits and vegetables in their diet. Increased cooking skills and knowledge about a variety of fruits and vegetables can mitigate the influence of barriers such as perceived lack of convenience, appearance, and novelty. It is beneficial if quick and easy recipes are developed and communicated to consumers. Moreover, associations between price and dietary patterns imply that food pricing policies such as taxing the less sustainable options or subsidizing the more sustainable alternatives can be an effective policy to encourage (discourage) the (un)sustainable dietary patterns.

This study has some limitations. The first limitation is the lack of a well-defined sustainable food consumption pattern in the Norwegian context, which can be considered a challenge inherent to sustainability research in general. A comprehensive definition of a sustainable diet, which is well-adjusted to the local context, is essential to accurately evaluate food consumers' consumption pattern in the country of study. The upcoming edition of NNR in 2022 is supposed to integrate several recent researches on sustainability in their recommendations. Therefore, an updated version of the Norwegian official dietary guidelines with emphasize on sustainability aspects can be expected accordingly. Future studies can benefit from this updated version of the dietary guidelines to better evaluate food consumption patterns from a sustainability perspective. Second, the FFQ does not include all the questions to sufficiently detect a (un)sustainable diet. It lacks questions such as consumption frequencies of seasonal fruits and vegetables, amount of food waste, items' packaging, food consumed away from home, etc. Using a tailormade FFQ with a sustainability focus would improve our understanding of sustainability aspect of food consumption

patterns. Third, the elicitation method used for food values only identified the most and least important food values for each respondent. This format does not provide any information about the relative importance of the 10 other food values. Future studies could use a repeated best-worst scaling approach. For more discussion of this method see Bazzani et al. (2018) and Lusk and Briggeman (2009). Fourth, the OCEAN traits are measured using a short version of the Big Five personality model. More extensive versions of the Big Five personality model would capture individuals' personality more precisely, which might detect stronger associations. However, to alleviate the third and fourth limitations one must use extensive measurement of the OCEAN traits or conduct choice experiments with repeated choice tasks. Implementing such methods is difficult in large scale surveys with wide coverage of the topics such as NMS, and would come at substantial costs in terms of time, money, and respondents' attentiveness to the survey.

6. Conclusions

Data on food consumption frequency from a nationally representative sample of Norwegians were used to evaluate general dietary patterns from a sustainability perspective. The study contributes to the literature in sustainable food consumption, by investigating larger parts of individuals' dietary patterns rather than focusing on the choice or consumption frequency of a single product. Initially 315 food items were selected. With the use of PCA the number of items was reduced to 105. The result of the PCA detected three prevalent dietary patterns among respondents and these patterns were labeled as sustainable, traditional, and unsustainable. Moreover, instead of the one-size-fits-all definition for a sustainable food consumption pattern, these dietary patterns were evaluated by considering aspects of the sustainability in the Norwegian context.

Respondents' personality traits were measured by the Big Five personality model. Respondents' motivations for adopting a certain dietary pattern were measured by 12 food values. Personality traits and food values were significantly associated with the dietary patterns. Sociodemographic factors, personality traits, and food values explained between 19%-46% of the variance of the dietary patterns. In all models, most of the variance was

accounted for by the sociodemographic variables, while food values explained more than the personality traits.

The associations between food values and dietary patterns indicate that individuals expect to achieve certain outcomes from the food they consume, such as eating something local, tasty, cheap, convenient, or with little environmental impact. Consumers' heterogeneity is important for the adoption of different dietary patterns. While some adopt a dietary pattern to reduce the environmental impact of the food, others are more concerned about fairness towards those involved in the food supply chain and protecting local production. Different sustainability concerns result in different food consumption patterns that need to be further studied in terms of its costs and benefits from a sustainability perspective. Debates about what actually constitute sustainable food consumption and production are not limited to Norway. To ensure transition towards a sustainable food system, a well-defined sustainable diet which entails aspects of sustainability in a local context must be provided and made accessible to consumers.

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Appendix (or for referees' use)

Principal Component Analysis (PCA)

PCA is a multivariate technique widely used for data reduction purposes, such as food frequency questionnaires, where the objective would be to reduce the large number of observed variables to a smaller subset of principal components. The methodology in PCA is to generate the set of normed linear combinations of random variables that have the maximum variance.[1] I follow Jöreskog, Olsson, and Wallentin (2016) in the specification of the PCA model. Let $x = (x_1, \dots, x_p)'$ be a vector of p observed random variables, and $c = (c_1, \dots, c_p)'$ a vector of uncorrelated components constructed from linear combinations of p variables in x such that:

$$c = A'x \tag{1}$$

where A is a $p \times p$ matrix representation of linear transformation of xs, in which column j is the vector of linear transformation generating c_j. PCA's objective is to maximize the variance of these normed linear combinations:

$$\text{Maximize} \quad \text{var}(c) = \text{var}(A'x) = A'\Sigma A \qquad \text{Subject to } A'A = I_p \tag{2}$$

where Σ denotes the covariance matrix of x. The maximization problem is solved by maximizing the Lagrangian function:

$$\mathcal{L} = A'\Sigma A - \Gamma\left(A'A - I_p\right) \tag{3}$$

[1] Normed linear combination of p random variables; $a_1x_1 + \cdots + a_px_p$, is defined such that $a_1^2 + \cdots + a_p^2 = 1$.

where Γ is a diagonal matrix of p Lagrangian multipliers; γ. The first-order conditions (FOCs) are $\frac{\partial \mathcal{L}}{\partial A}$ and $\frac{\partial \mathcal{L}}{\partial \Gamma}$, and imply $\Sigma A = \Gamma A$ and $A'A = I_p$. The FOCs indicate that the γs are the eigenvalues of Σ with associated eigenvectors represented in columns of A; $\Sigma A = \Gamma A$. Moreover, using $A'A = I_p$ and some matrix manipulations one can show that $A'\Sigma A = \Gamma$; that is, the eigenvalues are in fact the variances to be maximized. The matrix of eigenvectors, A, is a matrix which transforms Σ into a diagonal matrix Γ. In other words, A is a matrix representation of linear transformations of x into c uncorrelated components.

From p random variables, one can extract p uncorrelated components, such that the first component account for the most variance, the second component accounts for the second most variance, and so on until all the variance in the data is accounted for. The extracted components can also be rotated orthogonally or obliquely to achieve simpler structure. In practice, one hardly ever retains all the principal components, and chooses rather the first k components that capture the essence of most important variability in the data, and ignore the $p - k$ remaining components with small eigenvalues; γ.

Once k principal components are retained, scores for these principal components can be predicted. The k predicted scores can replace the original set of observed p variables, and be used for subsequent analyses. Predicted scores using the regression method in Stata/MP 15.1 is computed following Thomson (1951) as:

$$\hat{f} = \Phi\Lambda'\Sigma^{-1}x \qquad (4)$$

where Φ is the correlation matrix of the components, which is an identity matrix if the components are unrotated or orthogonally rotated, Λ is the matrix of unrotated or orthogonally rotated loadings and are calculated as $\Lambda = A_k\sqrt{\Gamma_k}$, where A_k a submatrix of the first k columns of A, and $\sqrt{\Gamma_k}$ is a diagonal matrix of the squared root of the first k eigenvalues; γ.

Hair et al. (2014) and Jöreskog, Olsson, and Wallentin (2016) discuss several criteria to determine the number of components. One criterion is to retain all the components with eigenvalues above 1. Another criterion is to plot the eigenvalues against their rank (screeplot), and retain the components to the left of the 'elbow' in the curve. Aiming to achieve a certain percentage of total variance explained is another criterion. No absolute threshold exists, but it is recommended to retain components that explain up to 95% of the

total variance (Hair et al., 2014: 107). However, in social science where information is less precise, it is common to consider solutions with 60% or even less share of the variance explained (Hair et al., 2014: 107). One should also take the interpretability of the components into account. As mentioned by Jöreskog, Olsson, and Wallentin (2016) there is no unique way to determine the number of factors, and the suggested criteria are rather ad hoc rules, which is also a limitation of conducting such exploratory analyses.

Table A1. Three-factor solution from PCA on 105 food items [a]

	Unsustainable	Sustainable	Traditional	h^{2} [b]
American	**0.61**	-0.02	-0.10	0.38
Taco sauce in glass	**0.56**	0.10	-0.10	0.34
Mexican	**0.55**	0.11	-0.22	0.36
Hamburger	**0.54**	-0.11	0.02	0.30
Italian	**0.49**	0.26	-0.19	0.35
Minced meat	**0.48**	-0.11	0.10	0.25
Frozen pizza	**0.46**	-0.18	0.06	0.24
French fries	**0.46**	-0.10	0.10	0.23
Dry pasta	**0.45**	0.25	-0.13	0.28
Lasagna	**0.44**	0.03	0.09	0.20
Homemade spaghetti	**0.44**	0.30	-0.14	0.30
Homemade pizza	**0.43**	0.14	0.14	0.22
Pizza bun	**0.43**	0.01	0.05	0.19
Grill sausage	**0.43**	-0.16	0.25	0.28
Ready meal spaghetti from store	**0.42**	-0.02	0.05	0.18
Stew, ready from bag or box	**0.41**	-0.13	0.23	0.23
Snack food, e.g., noodles, soup in cup	**0.40**	-0.04	0.01	0.16
Noodles	**0.40**	0.15	-0.04	0.19
Shredded cheese for pizza	**0.40**	0.06	0.02	0.16
Candy from the shelf	**0.40**	0.02	0.00	0.16
Maize	**0.39**	0.25	0.00	0.22
Snacks from the gas station	**0.39**	-0.07	0.00	0.16
Warm cheese sandwich	**0.38**	0.03	0.04	0.15
Chips	**0.38**	-0.03	0.02	0.15
Packaged candy	**0.38**	-0.05	0.02	0.15
Minced meat, lean	**0.37**	0.09	0.04	0.15
Wraps	**0.37**	0.20	-0.10	0.18
Chips, low fat	**0.37**	0.02	0.11	0.15
Sprite, original	**0.37**	-0.10	0.07	0.15
Minced pork	**0.36**	-0.05	0.09	0.14
Hotdog bread	**0.36**	-0.10	0.12	0.16
Bakeries from convenient store	**0.36**	-0.05	0.03	0.13
Snacks from convenient stores	**0.36**	-0.05	-0.06	0.13
Fresh pasta	**0.35**	0.19	0.00	0.16

Energy drinks	**0.35**	-0.06	-0.02	0.12
Beef	**0.34**	0.01	0.04	0.12
Ice tea	**0.34**	-0.01	-0.01	0.11
Ready sauce in box or bag	**0.33**	0.02	0.06	0.11
Cake from mix	**0.33**	-0.02	0.12	0.12
Ketchup	**0.33**	-0.08	0.18	0.14
Hotdogs	**0.32**	-0.16	0.09	0.14
Ready meals, deep frozen	**0.32**	-0.15	0.06	0.13
Hermetic meals	**0.32**	-0.17	0.16	0.15
Ice coffee	**0.32**	0.04	0.00	0.11
Milkshake or smoothie	**0.32**	-0.03	-0.06	0.11
Coca cola, original	**0.32**	-0.18	0.05	0.14
Fresh salad	-0.01	**0.64**	0.04	0.41
Garlic	0.09	**0.64**	-0.13	0.44
Onion	0.02	**0.62**	0.05	0.39
Bell pepper	-0.04	**0.61**	0.05	0.37
Fresh spice plants	-0.07	**0.60**	-0.02	0.36
Olive oil	0.01	**0.59**	-0.09	0.35
Raw vegetables	-0.07	**0.59**	0.07	0.36
Tomatoes	-0.21	**0.58**	0.14	0.40
Avocado	0.08	**0.53**	-0.15	0.31
Cucumber	0.05	**0.52**	0.11	0.28
Balsamic	-0.08	**0.52**	-0.04	0.27
Fried vegetables	0.17	**0.51**	-0.11	0.30
Rapeseed oil	0.00	**0.49**	0.00	0.24
Rocket salad	0.04	**0.48**	-0.04	0.24
Squash/eggplant	0.04	**0.48**	-0.08	0.24
Vegetarian dish, vegetable soup/pai	0.07	**0.47**	-0.02	0.23
Parmesan or mozzarella cheese	0.09	**0.45**	-0.10	0.22
Homemade dressing	-0.09	**0.43**	0.00	0.19
Fresh fruit for dessert	-0.16	**0.42**	0.17	0.23
Soya oil	0.14	**0.41**	-0.06	0.19
Mushroom	0.16	**0.39**	-0.07	0.18
Apple	-0.19	**0.38**	0.28	0.26
Mango	0.13	**0.37**	0.04	0.15
Melon	0.12	**0.36**	0.08	0.15
Asparagus	0.06	**0.35**	0.13	0.14
Beans	0.09	**0.34**	-0.01	0.12
Natural yoghurt	-0.08	**0.34**	-0.03	0.12
French dishes	0.20	**0.32**	-0.06	0.15
Oatmeal	-0.02	**0.32**	0.03	0.10
Raspberry	-0.04	**0.32**	0.17	0.13
Crème fraiche	0.12	**0.32**	0.07	0.12
Wok	0.26	**0.31**	-0.11	0.17
Blueberry	-0.05	**0.31**	0.12	0.11
Banana	0.03	**0.30**	0.12	0.11

Cooked potato	**-0.31**	-0.09	**0.61**	0.48
Meatballs (Kjøttboller)	0.18	-0.11	**0.60**	0.41
Potato	-0.27	-0.03	**0.58**	0.41
Norwegian burger (Karbonader)	0.18	-0.07	**0.49**	0.28
Pollock fillet	-0.04	0.07	**0.47**	0.23
Fish gratin or fish pai	0.10	0.03	**0.45**	0.21
Flat bread	-0.16	0.02	**0.45**	0.23
Lam, pork, beef baked in oven	0.17	0.10	**0.44**	0.23
Fish pudding	0.04	0.00	**0.44**	0.19
Traditional Norwegian dishes	0.20	-0.05	**0.43**	0.22
Fish balls	0.12	0.00	**0.41**	0.18
Rice pudding	0.15	-0.02	**0.40**	0.19
Potato pudding from bag	0.22	-0.10	**0.40**	0.22
Sour cabbage	-0.01	0.07	**0.40**	0.17
Homemade cake	-0.08	0.09	**0.40**	0.17
Pork chops	0.13	-0.01	**0.39**	0.17
Fish cake	-0.01	0.12	**0.39**	0.17
Homemade jam	-0.3	0.16	**0.37**	0.25
Waffle	0.10	0.03	**0.35**	0.13
Vegetable stew	-0.04	0.21	**0.34**	0.16
Homemade bakery	0.13	0.03	**0.34**	0.14
Aged yellow or white cheese	-0.19	0.09	**0.33**	0.15
Pollock	-0.14	0.15	**0.32**	0.14
Rutabaga	-0.09	0.25	**0.32**	0.18
Potato bread (lefse)	0.05	0.00	**0.32**	0.11
Eigenvalues [c]	8.73	8.11	5.34	
Var.% [d]	8.31	7.72	5.08	

Notes: [a] Principal component analysis conducted using -factor- command and -pcf- option in Stata/MP 15.1. Followed by an orthogonal varimax factor rotation and based on 3,210 observations. Factor loadings of the three dietary patterns on the 105 food items. Factor loadings above |0.3| are printed in bold. [b] h^2 refers to the communalities, which measure the level of variance in the food group that is accounted for by three factors. [c] Eigenvalues of each factor. [d] Percentage of the total variance in the 105 food groups explained by the factor.

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The thesis consists of an introduction and four independent papers. The four papers contribute to the body of literature in consumers' food-related behavior through integration of personality traits and food values.

Paper (I) investigates how personality traits influence the relative importance of food values for consumers in Norway and the US.

Paper (II) explores the role of personality traits in determining attitudes towards genetically modified food among the Norwegian consumers.

Paper (III) extends the work in paper (II) by including food values to investigate the role of subjective beliefs. The paper compares consumers' perceptions about genetically modified food in Norway and the US.

Paper (IV) studies the sustainability aspect of the most prevalent dietary patterns among Norwegians. The role of individuals' personality traits and food values in prevalence of such diets are investigated.

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