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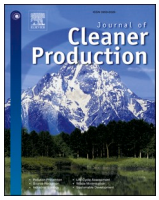

Consumer perceptions and attitudes towards climate information on food

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ABSTRACT

The food sector is a major contributor to climate change, and reducing meat consumption is important to achieve significant reductions in global carbon emissions. The implementation of information policies to reduce carbon emissions from red meat consumption entails understanding of how such information is expected to be received and used by consumers. This study uses survey data from a consumer panel, and match this with data on the same respondents' actual purchase behavior based on scanner data. Individuals with lower knowledge levels about the climate impact from food purchase the highest share of red meat, and the lowest share of sustainability labelled products. This indicates that information provision has the potential to increase knowledge among individuals with the highest climate impact. Four sub-groups of consumers are identified in a latent class cluster model based on their motivations for consuming or avoiding meat. It is mainly the 'meat reducers' and 'meat avoiders' that are interested in using climate information when purchasing food. However, individuals in these sub-groups already purchase the least amount of meat and the highest amount of sustainable products. These findings point to limitations with climate information as a policy instrument, and suggests that other measures are needed as complements to initiate and achieve the necessary changes in consumption patterns.

1. Introduction

Present food consumption patterns constitute a growing concern with respect to environmental impact as well as public health (Godfray et al., 2018; Willet et al., 2019). In particular, production of meat causes high levels of greenhouse gas emissions relative to other protein sources, and requires larger land areas (de Vries and de Boer, 2010; Poore and Nemecek, 2018; Springmann et al., 2018). Moreover, high consumption of processed and unprocessed red meat is associated with increased risk of diseases such as stroke, cancer, diabetes and coronary heart disease (Wang et al., 2016; Willet et al., 2019; Wolk, 2017). Reduction in red meat consumption is thus motivated by both environmental and health aspects (Hallström et al., 2014), and a more sustainable food system will require a shift from animal proteins to plant based protein (Godfray et al., 2018; Willet et al., 2019). Yet, consumption of meat and dairy is rising globally, and in most high-income countries the per capita meat consumption is high (Godfray et al., 2018). Thus, initiatives and policies to shift consumer choices of meat and dairy, such as government interventions and private initiatives, are increasingly called for.

Different policy instruments are available to affect consumption patterns towards reduced meat consumption, including fiscal instruments, such as imposing taxes or withdrawing subsidies, and regulatory instruments, such as requirements in the production stages. Another type of instrument is to assist consumers with information campaigns or with food labels to increase knowledge and provide support at the point of purchase. The effects of information as an instrument to shift consumption patterns assumes that consumers lack sufficient insights about the climate impact from different food types (Just and Byrne, 2019), although information may also increase salience and serve to remind already knowledgeable consumers. It further assumes that consumers wish to take the information into consideration and that they desire to reduce their climate impact from food consumption (Just and Byrne, 2019). Economic theory posits that individuals use information in their decision making if it is perceived as relevant, and if the cost of searching and evaluating the information does not exceed the benefits (Stigler, 1961). As such, two central questions arise: 1) is there a knowledge gap regarding climate impact from food among consumers, such that they lack the necessary understanding? 2) do consumers desire information about the climate impact from food? Importantly, measures that can affect consumers with the highest meat consumption have the largest potential to reduce climate impact.

Concerning the first question, whether there is a knowledge gap regarding climate impact from food among consumers, there is evidence that consumers' state of knowledge about carbon emissions from food in

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general, and meat in particular is relatively low (Hartikainen et al., 2014; Hartmann and Siegrist, 2017; Macdiarmid et al., 2016; Sanchez-Sabate and Sabaté, 2019; Wellesley et al., 2015), where the emissions from meat are underestimated compared to vegetable products (Camilleri et al., 2019; Shi et al., 2018). Some studies find that awareness on environmental impact of food production varies with demographic characteristics, were females have higher awareness of the climate impact from meat, while characteristics such as age and educational levels are not important predictors (Hartmann and Siegrist, 2017; Sanchez-Sabate and Sabaté, 2019). The overall low awareness suggests that increasing the level of knowledge among consumers through the provision of information has the potential to bridge a knowledge gap. This study investigates heterogeneity in consumers' knowledge about climate impact from food, in particular how the knowledge levels relate to current food purchase patterns.

The second question concerns consumers' desire to access information about the climate impact from food. To understand the potential of information as an instrument to direct consumption towards reduced meat intake, an important question is how individuals with different motivations for consuming or avoiding meat will receive climate information. Meat has an important role in the diet for many individuals. Important motivations for consuming meat are the 4Ns; that it is 'natural', 'necessary', 'normal' or 'nice' (Piazza et al., 2015; Valli et al., 2019), while health and sustainability are important motivations for avoiding meat (Valli et al., 2019). For example, many consumers believe that meat is difficult to replace from a nutritional perspective, that it is natural to eat and part of their culture, and they enjoy the taste of meat (de Boer et al., 2017; Lacroix and Gifford, 2019; Schösler et al., 2014). Lacroix and Gifford (2019) and Malek et al. (2019) identified consumer segments based on reasons for consuming (or avoiding) meat, conducting latent profile and factor analysis. In line with these studies, this study explores consumer segments based on perceptions and motivations for consuming or avoiding meat, while this study additionally investigate how these relate to perceptions and attitudes towards climate information. A further contribution is that this study explores the actual purchase patterns on the market among the identified consumer segments.

The objective of this study is to investigate if consumers' knowledge levels about climate impact from food products vary with their current consumption patterns. For example, do less knowledgeable consumers purchase foods that cause more climate emissions? A second objective is to explore consumers' attitudes and perceptions regarding climate information, and if this varies with the motives for consuming or avoiding meat.

2. Methods

2.1. Latent Class Cluster Analysis

To identify sub-groups of individuals that hold similar motivations regarding meat consumption, and explore their attitudes and perceptions towards climate information, a Latent Class Cluster Analysis was applied (LCCA[1]) (Masyn, 2013; Nylund-Gibson and Choi, 2018). The motivation for LCCA is comparable to other cluster analysis methods, and enable identification of groups of individuals that have responded similarly to a set of questionnaire items (Masyn, 2013).[2]

An LCCA consists of two parts: a measurement model and structural model. The measurement model describes the response patterns to the indicator questions (motivations for consuming or avoiding meat) in each latent class while the structural model describes the latent class membership probabilities.

To determine the best relative fit for the measurement model, i.e., which number of latent classes is most suitable, two categories of comparisons were used: the inferential and the information-heuristic. The inferential category included likelihood ratio tests, where successive pair-wise comparisons between models are performed. The information-heuristic category included a range of different measures (e.g., BIC, SABIC, CAIC). There is no consensus on which measure to use in the selection process (Nylund-Gibson and Choi, 2018).

The extension to LCCA was adopted by including covariates regarding perceptions on climate information as predictors of class membership (Lanza et al., 2007). It is recommended that the model with the most suitable number of classes is selected prior to including covariates (Masyn, 2013). Hence, a series of LCCA models was estimated where only the indicators are included, with increasing numbers of classes to determine the most suitable specification. After selecting the class structure, covariates were included, which enables the investigation of whether there are differences in attitudes and perceptions towards climate information between the meat-motivation classes.

Further, following estimation, each individual can be assigned to the latent class with the highest membership probability. Such classification can be used for describing the latent classes on measures of interest (Lanza et al., 2007). This study thus examines the purchase patterns in each of the identified classes, to explore if there are differences in consumption related to the motivations regarding meat consumption, and the perceptions and attitudes towards climate information among the latent classes. A more detailed description of the LCCA method is available in Section S2 in Supplementary materials.

3. Data and descriptive statistics

3.1. Sample and participants

Data was collected in a survey distributed to a consumer panel, and this was matched with data on the actual purchases by the same individuals. The questionnaire was developed and adjusted following two focus group sessions, and a pilot study distributed to a consumer panel ($N = 400$).[3] The final questionnaire was distributed to a consumer panel in November 2019, resulting in 1052 responses. Participants have registered voluntarily for participation in the panel, they were informed that they could withdraw at any point, they were informed about the purpose of the study, and given contact details to the researcher. Any personal information about the participants was de-identified in the data. This type of study and data collection does not require approval according to the Swedish Ethical Review Authority (Swedish Ethical Review Authority, 2021). Respondents answered the survey online. The panel was held by Coop, which is among the largest retailers in Sweden, and it was not expected that the socio-demographic composition of the panel to differ systematically compared to the overall Swedish population. However, the socioeconomic characteristics of the sample revealed that the distribution of age and level of education was not representative of the Swedish population. Weights are used in our estimations to

[1] LCCA is distinctly different from latent class logit models, which captures preference heterogeneity, by estimate choice probabilities based on a discrete outcome (such as a chosen alternative in purchase data or choice experiment data).

[2] Cluster analysis and LCCA are person-oriented approaches that describe similarities and differences between individuals. This should not be confused with a variable-oriented approach, where associations between items are described. Statistical methods for such analysis include factor analysis (Nylund-Gibson and Choi, 2018).

[3] The pilot study included other sections of questions that were used for another study (Edenbrandt et al., 2021b).

correct for this. Furthermore, the sample showed a slight over-representation of females, which was not corrected for because women are more often responsible for food purchases in households. Full details on the descriptive statistics are available in Section S1 in Supplementary Materials.

The survey included a first section with questions related to meat consumption. Five questions measured motivations for consuming red meat, relating to 'natural', 'necessary', 'normal' or 'nice' (Macdiarmid et al., 2016; Piazza et al., 2015; Valli et al., 2019). In addition, two key motivations for avoiding meat were included; 'health' and 'sustainability' (Valli et al., 2019). There are several other reasons for avoiding meat, including animal welfare. Respondents indicated their agreement to the following seven statements about red meat: 'I like the taste', 'It is difficult to replace from a nutritional perspective', 'It is unhealthy and should be consumed in small amounts', 'Eating certain meat dishes is part of my identity', 'It has a large negative impact on the climate', 'It has a central role in most meals in my household', 'It is natural to eat'. Responses were given on a Likert-type scale (1 = strongly disagree–5 = strongly agree), and statements where presented in a randomized order. The items were based on the findings from (Valli et al., 2019), while the wordings of the statements were adapted following the focus groups sessions and the pilot study. Next, respondents indicated their subjective level of knowledge about the climate impact from food ('How much knowledge would you say you have about the climate impact from food products in general?'). Responses were given on a five point scale from 'No/very little knowledge' to 'Very large knowledge').[4] Finally, respondents indicated their agreement to the following six statements regarding attitudes and perceptions towards climate change and information: 'I do not trust that information about the climate impact from food is correct', 'Climate change is not caused by humans', 'Reducing climate impact from consumption is not a personal responsibility', 'Climate information makes me feel bad', 'I don't know how to use/interpret climate information', 'I wish to use climate information when I purchase food'. The full survey is available in Supplementary Materials.

3.2. Individual purchase profiles

The survey data were matched with actual purchase data for the same individuals, including each individuals' purchases in all of the retailer's stores within Sweden during 2019. The actual purchase data was thus provided by Coop, and they de-identified the data prior to giving us access to the data material. Individuals with a total annual spending below 5000 SEK (~600USD) on in Coop stores were excluded from the further analysis because it is not reasonable to assume that their purchase data are representative for their overall food purchases. This removal resulted in a sample of 766 individuals that were included in the analysis.

Aggregate purchases were obtained for key product categories (meat and meat products, fruit and vegetables, fish and seafood, poultry), expressed as a share of the total food purchases (non-food products are excluded). Moreover, the share of health labelled food products was obtained (this includes products labelled with the national Nordic keyhole, and/or labelled low fat/sugar). Finally, the share of sustainability labelled products expressed as a share of purchases on both food and non-food categories sold in the grocery stores was obtained (such as paper towels). The sustainability labels included 'Bra Miljöval' (Naturskyddsföreningen, 2021), EU-organic label, FSC, Swedish Organic label ('KRAV'), MSC, Rainforest alliance, the Nordic Swan Eco-label (Miljömärkning Sverige, 2021) and utz. Note that many products have several of these labels.

4. Results

4.1. General knowledge levels about climate impact from food

Overall, few individuals indicated to have a very high level of knowledge about the climate impact from food products in general (5%), while almost a fifth have high levels of knowledge (17%). The majority were somewhat knowledgeable (60%), or had low levels of knowledge (15%) but only 3% had no or very little knowledge. The level of knowledge were higher among individuals with a high education level, and the lowest among the least educated (Pearson χ^2, $p < 0.01$). There were also differences in the level of knowledge between age groups, with a higher level of knowledge among younger individuals compared to the middle-aged or older groups (Pearson χ^2, $p < 0.05$). There were no evidence of gender-based differences in knowledge levels.

Individuals with very high or high levels of knowledge about the climate impact from food products have a significantly larger share of sustainability-labelled purchases (Fig. 1). The average share of sustainability labelled products for individuals with the highest level of knowledge were 24 percent, while only 12 percent for the least knowledgably. Moreover, individuals with very high or high levels of knowledge about the climate impact from food products purchase more fruit and vegetables and less meat products compared to the less knowledgeable, a consumption pattern that is in line with lower climate impact. There are also differences in the share of health-labelled products between the indicated levels of knowledge, although these differences are mainly between the individuals with no/very little knowledge and the very knowledgeable.

4.2. Motivations for consuming and avoiding meat

A summary of responses to the questions concerning motives for meat consumption (indicators), and attitudes and perceptions regarding climate information on food (covariates), are presented in Section S3 in Supplementary Materials. The inferential and information-heuristic measures of relative fit are presented in Section S4. For all criteria, the model fit improves until seven or nine classes, depending on the measure. In such cases, it is recommended that the relative improvement rate is examined (Masyn, 2013; Nylund-Gibson and Choi, 2018). The improvements are relatively small after four latent classes. While one of the identified classes is small in this model (6%), most parameters are statistically significant in all classes, and the existence of this small class is supported in the literature (meat-avoiders is a distinct, yet small, consumer segment) (Malek et al., 2019). Hence, analysis proceeds with the four-class model, and re-estimate this model while including the covariates (Masyn, 2013). Parameter estimates for this model are presented in Section S5, while within-class distributions of the indicators and covariates are used for interpreting the results, as displayed in Table 1[5] In the following, each of the classes are labelled and described based on the meat-motivation indicators, followed by descriptions of perceptions and attitudes towards climate information. While the statistical significance for differences between classes is not presented in Table 1, only findings that are statistically significant are discussed. Table 2 describes purchase patterns in the classes, based on the predicted class membership for each individual.

The first class, which is also the largest (51%), is referred to as *habitual meat-eaters*. Individuals in this class hold positive perceptions regarding meat; they like the taste of it, and consider eating it to be

[4] The survey also included a section with a choice experiment that is used in (Edenbrandt and Lagerkvist, 2021), which explores preferences for specific protein products, and how a specific carbon label impact their willingness to pay. The research questions do thus complement this study, and the questionnaire material used does not overlap between the studies.

[5] Additional information is available in Section S6. Paired comparisons between the classes for each of the indicators and active covariates are provided in Section S7.

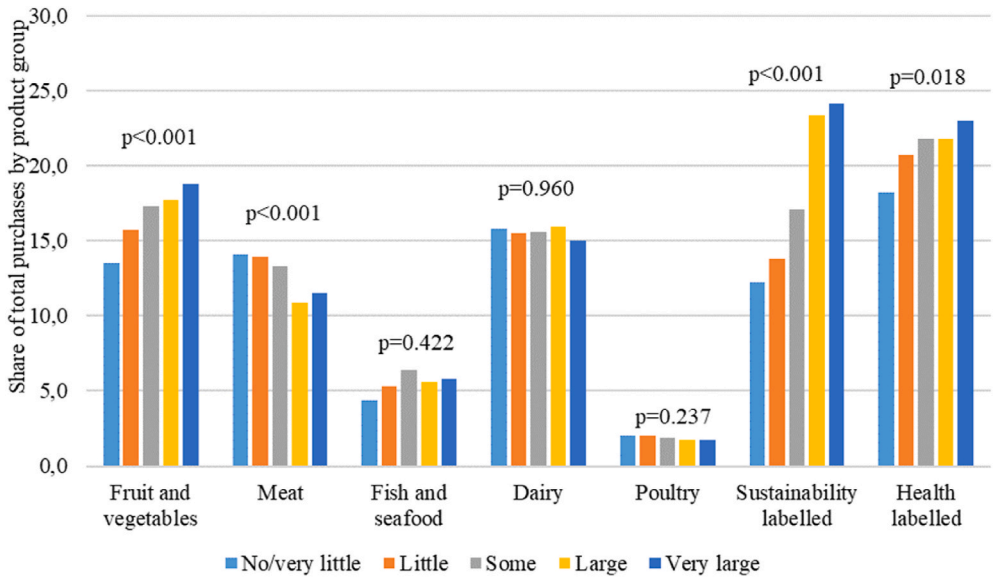

Fig. 1. Purchase patterns by level of knowledge about the climate impact from food
Note. Sorted by response to the question: 'How much knowledge would you say you have about the climate impact from food products in general?' P-values below 0.05 indicates statistically significant differences on 5% level between the knowledge level groups (ANOVA-test).

Table 1
Descriptive statistics for four-class latent class model including covariates.

	Habitual meat eaters	Meat-reducers	Devoted meat eaters	Meat avoiders
Proportion of class membership	51%	27%	16%	6%
Indicator questions (mean values)[a]				
I like the taste	4.4	3.5	5.0	2.1
It is difficult to replace from a nutritional perspective	3.6	2.3	4.7	1.3
It is unhealthy and should be consumed in small amounts	2.8	3.5	1.6	5.0
Eating certain meat dishes is part of my identity	3.4	1.8	4.6	1.0
It has a large negative impact on the climate	3.5	4.2	2.3	4.7
It has a central role in most meals in my household	3.8	2.1	4.7	1.0
It is natural to eat.	4.2	3.1	5.0	1.4
Covariates (% that agree)[b]				
I do not trust that information about the climate impact from food is correct	22.9	10.3	41.7	6.9
Climate change is not caused by humans	1.9	0.3	7.5	0.0
Reducing climate impact from consumption is not a personal responsibility	9.2	4.2	23.8	0.0
Climate information makes me feel bad	11.6	9.9	6.4	38.3
I don't know how to use/ interpret climate information	34.5	17.2	24.8	0.0
I wish to use climate information when I purchase food	42.2	87.6	24.8	99.9

Note. N = 776. [a] Agreement to the indicator statements regarding red meat are given on a five-point scale (1 = strongly disagree–5 = strongly agree). [b] Agreement to the covariates statements are given on a binary scale and dummy coded (1 = agree with the statement).

Table 2
Actual purchase behavior for individuals within the four-class latent class model.

	Latent classes			
Average share of spending by product category	Habitual meat eaters	Meat-reducers	Devoted meat eaters	Meat avoiders
Fruit and vegetables	16.4	18.4	14.9	21.8
Meat products	13.8	9.3	16.1	4.7
Fish and seafood	5.1	5.2	4.7	4.5
Dairy	15.5	15.9	14.4	10.8
Poultry	1.9	2.3	1.9	0.9
Sustainability-labelled	16.6	22.0	11.3	30.4
Healthy alternative	20.2	23.6	18.5	24.0

Note: Average share of household spending in Coop stores during 2019.

natural. Meat holds an important place in their meals, and they do not agree that red meat has a large negative impact on the climate. Thirty-five percent of the respondents in this class state that they do not know how to use/interpret climate information, while 42% state that they would like to use such information when purchasing food. Thus, in this segment, there does exist some degree of awareness, and perhaps weak interest, in making behavioral changes. As shown in Table 2, on average, individuals in this class spend 13.8% of their food budget on meat products. Further, 16.6% of their overall spending in coop stores are sustainability labelled.

The second class (27%) are referred to as *meat-reducers*, following previous research (Lang, 2020; Sanchez-Sabate and Sabaté, 2019). Individuals in this class enjoy the taste of meat, although not to the same extent as the habitual meat-eaters. It is also clear that meat plays a less central role for individuals in this class, and they are more inclined to believe that meat has negative impacts on health and the climate. Many individuals in this segment want climate information when purchasing food (87.6%), while 17.2% find it difficult to use and interpret such information. The average share of the food budget spent on meat products is lower in this class compared to the habitual meat-eaters (9.3%). Moreover, on average, individuals in this class have a higher share of sustainability-labelled purchases and food products categorized as healthy compared to the habitual meat-eaters.

For the third class, the *devoted meat eaters* (16%), meat is a very important part of their diet. They enjoy the taste and consider it natural

to eat meat. They believe meat is difficult to replace from a nutritional perspective, and that it is not unhealthy. They have low agreement with meat having negative impacts on the climate. Twenty-four percent of the individuals in this class do not consider it a personal responsibility to reduce their climate impact from consumption, and 24.8% find it difficult to use and interpret climate information. Moreover, 75.2% of the individuals in this class do not wish to use climate information when purchasing food. The purchase patterns among individuals in this class reveal that they purchase the largest share of meat products (16.1%), and the lowest share of fruits and vegetables. Moreover, they have the lowest share of both sustainability-labelled purchases and food that are categorized as healthy.

In the fourth class, the *meat-avoiders* (6%) have overall negative perceptions of meat and agree with the negative effects from meat consumption. Individuals in this class consider it a personal responsibility to reduce their climate impact from consumption, and have the highest degree of feeling bad when hearing about climate change (38.3%). They do not find climate information difficult to interpret and have the largest interest in using climate information (99.9%). They purchase the largest share of fruits and vegetables (21.8%) and the lowest share of meat (5%) and dairy products. They also purchase the largest share of sustainability-labelled products and those categorized as healthy.

5Discussion

To reduce carbon emissions from the food sector there is a need to lower meat consumption (Godfray et al., 2018). However, such shifts in purchase patterns require that consumers have adequate knowledge about the climate impact from different food types, and further relies on consumers' interest and motivation to adjust their food choices (Bonnet et al., 2020; Just and Byrne, 2019). This study investigates the levels of knowledge about climate impact from food among consumers, and how this relates to current consumption patterns. It further identifies latent sub-groups of individuals based on how they share motivations for consuming or avoiding meat, and how the attitudes and perceptions towards climate information vary between these sub-groups.

The analysis is based on data from a survey distributed to a consumer panel, and this is matched with data on the actual purchases by the same individuals. This combination of data sources is an important strength of this study, as it enriches the self-reported perceptions, attitudes and motivations regarding meat consumption with actual purchases. Importantly, given that information as a policy instrument has the largest potential to shift purchase patterns towards reduced climate impact if it strongly would affect consumers with the highest meat consumption, our approach of including actual purchase data in the analysis provides policy-relevant insights on the expected use of climate information and how this varies with current consumption patterns.

Importantly, the results show that the knowledge levels match with actual purchase patterns. Consumers with the lowest levels of knowledge about the climate impact from food also have the highest share of meat purchases. Furthermore, individuals with the lowest knowledge levels purchase the lowest share of sustainability labelled products and the lowest share of fruit and vegetables. They also purchase a lower share of health labelled food products compared to the most knowledgeable. In other words, individuals with the lowest level of knowledge display the purchase patterns with the highest climate impact. These findings suggest that the knowledge gap is largest among the consumers with the largest potential to reduce climate emissions. Increasing the knowledge levels, by providing climate information could alleviate the knowledge gap and potentially affect consumers with the largest potential to reduce carbon emissions. However, such effects rely on the assumption that consumers actually wish to access and use such information.

For this reason, attitudes and perceptions towards climate information in different consumer segments was explored. In line with previous studies (Lang, 2020), three sub-groups were identified; regular meat-eaters, meat-reducers, and meat-avoiders. However, this study further identified two sub-groups of meat-eaters; the *habitual meat-eaters* who show some interest in climate information and the *devoted meat eaters*, consisting of dedicated meat consumers who do not recognize a responsibility for reducing their climate impact. Further, the *meat-reducers* (27%) place less importance on meat in their meals and purchase fewer meat products. Finally, the *meat-avoiders,* which constitute a small proportion of consumers (6%), are the most interested in using climate information, and use the lowest share of their total food budget on meat products, and the highest share on sustainability-labelled products.

Individuals who perceive climate information as difficult to use are less interested in using such information in the purchase situation. Moreover, there is a negative correlation between recognizing the negative climate impact of meat production and interest in climate information. This relation between awareness of negative impacts from consumption and willingness to use information corroborate with (Edenbrandt et al., 2021a), which find that individuals that decline to view climate information in a set of purchase tasks in an economic experiment have lower problem awareness. This implies that it may be worthwhile to increase environmental literacy in conjunction with the implementation of specific information regarding the climate impact from food.

This study discuss climate information in general terms, as the focus is on consumers' interest regarding information about climate impact from food in general. It should be noted that information provision can take different forms, including public information campaigns and point-of-purchase information in the form of carbon labels on products. The content and design of information are important predictors of the understanding, use and effect on behavior (Rondoni and Grasso, 2021). Evaluating the effects from different information treatments, and combinations of different types of information sources, is an important task for future research.

5.1. Limitations and future research

One of the limitations of this study is that it includes only a subjective measure of knowledge. Future studies should test the correspondence between subjective and objective knowledge in this area. Studies in other fields have found discrepancies between objective and subjective knowledge (House et al., 2004). If such discrepancies vary with purchase patterns, it could provide useful insights when planning information campaigns and other information instruments. Further, this study gives a picture of the state of knowledge, motivations and perceptions and attitudes towards climate information at a single point in time. Changes in social norms and other societal changes may result in changes in consumption patterns.

Another limitation with this study is that it is isolated to investigate climate and health related motives for reducing meat consumption. While a recent review identify health and environmental aspects as key motivators for avoiding or reducing meat consumption, there are other important motives, in particular animal welfare, which has not been investigated in this study (Valli et al., 2019).

5.2. Policy implications

Various policy instruments are available to achieve changes in purchase patterns towards reduced meat consumption. This includes financial instruments, such as implementing taxes on meat or removing existing production, or trade, subsidies. Further, it includes policy instruments that bans or imposes requirements in production methods. Another possible instrument to is to provide consumers with information about the climate impact of food to increase knowledge and provide support in the purchase situation. This study finds that *meat-reducers* and *meat-avoiders* have a high interest to receive climate information on

food. While this is promising with respect to the expected usage of climate information, these segments only constitute a third of all consumers in our sample. From the perspective of actual purchases, these two consumer segments already have the lowest meat consumption and the highest proportion of sustainability-labelled purchases. Next, turning to the meat-eating segment, the subdivision of this segment provides insights for policy makers and marketers. It points to the potential for influencing the *habitual meat-eater* sub-segment with information, while the *devoted meat eaters* are unlikely to be persuaded by such measures, and affecting these consumers will likely require that information instruments such as labels are differentiated in design and content to have adequate impact on purchase behaviors of these subgroups. Another and more indirect option would be to complement information with other measures (fiscal measures and/or policy regulation). The meat-eater segment – the devoted meat eaters in particular – perceive red meat as highly nutritious and do not believe that there are negative health effects from consuming red meat. For this reason, the results suggest that it is less likely that combining climate information with further health-related information will have a substantial impact on their meat consumption. However, other ways of differentiating climate information to target different subgroups of consumers with varying food motives is a potential measure that needs further investigation.

6. Conclusions

This study finds that consumers with the lowest levels of knowledge about the climate impact from food display the purchase patterns with the highest climate impact. A major policy challenge is how, if at all, information can be used to attract and engage consumers who have the potential to contribute most to a reduction in meat consumption yet are the least likely to be affected by information campaigns. This study finds that it is mainly the 'meat reducers' and 'meat avoiders' sub-groups of consumers that are interested in using climate information when purchasing food. However, individuals in these sub-groups already purchase the least amount of meat and the highest amount of sustainable products. In sum, the results within this study suggests that climate information in food is expected to achieve only limited reductions in climate impact. An important strength with information as a policy instrument is the political feasibility, as it is less exposed to resistance among consumers compared to other policy instruments, including fiscal measures and regulations (Bonnet et al., 2020; Just and Byrne, 2019). Yet, the results of this study suggests that other instruments will be needed in addition to information to achieve further significant shifts in consumption. The effects of combining information with other policy instruments is an important question for future studies to target.

CRediT authorship contribution statement

Anna Kristina Edenbrandt: Conceptualization, Formal analysis, Methodology, Investigation, Writing – original draft, Writing – review & editing, Funding acquisition. **Carl-Johan Lagerkvist:** Conceptualization, Methodology, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2022.133441.

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