EUROPEAN DEMAND FOR PLANT-BASED DAIRY SUBSTITUTES: HYPE OR HOPE FOR A BROADER TRANSFORMATION OF THE FOOD SYSTEM?

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Abstract

The market for plant-based dairy products (PBDPs) as an alternative to foods of animal origin has seen steady growth rates for a number of years, delighting investors and leading to the introduction of many new PBDPs. However, it remains far from well understood if and to what extent this trend is only found among a narrow subgroup of consumers, or whether it signals the start of a broader transformation in European food demand. Assuming that a reduction in dairy consumption and its substitution with PBDPs can offer a route towards a more sustainable diet, this paper analysed a dataset of 3086 respondents from six European countries to identify influencing factors and possible barriers to PBDP consumption based on expectancy-value theory. The results show that active information-gathering and knowledge about plant-based dairy alternatives are the main drivers behind the decision to increase the frequency of PBDP consumption. Furthermore, existing attitudes about product characteristics can be seen as major barriers to consumers purchasing PBDPs. It is also evident that environmental, animal welfare and health aspects have an influence on the frequency of consumption and, for more dedicated consumers of PBDPs, play a greater role here. In summary, the hypothesis that consumer preferences for PBDPs will continue to change across Europe cannot be rejected.

Keywords

Expectancy-value theory, Beliefs, Attitude formation, Plant-based dairy products, Extended ordered probit models

1 Introduction

The demand for plant-based substitute products as an alternative to food products of animal origin has grown rapidly in recent years. Consumers in Germany and elsewhere in Europe are increasingly turning to plant-based substitutes of milk and milk products, partly out of curiosity, but also increasingly due to ethical concerns related to animal welfare, climate protection and environmental sustainability (BMEL, 2021a). Along with increasing demand, the market for plant-based substitute products is also rapidly growing, with the sales value for the entire plant-based food sector in Europe increasing by 49 % in the period from 2018 to 2020. A Europe-wide comparison has revealed that plant-based dairy alternatives are the leading segment among plant-based substitutes. The growth in sales volumes of PBDPs and the fact that they are becoming more established products in discount stores reflect a Europe-wide increase in the relevance of this product segment (SMART PROTEIN PROJECT, 2020).

Why should this trend potentially be relevant beyond actual sales figures that might interest investors and decision-makers in the food industry? The Green Deal presented by the European Union as a concept for achieving climate neutrality identifies sustainable food consumption as a core environmental issue alongside the reduction of greenhouse gases (BMEL, 2021b). Since in Germany, for example, 11 % of total GHG emissions in 2014 were related to agriculture (STEHFEST et al., 2009) and as livestock farming is in direct competition with crop production,

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the reduced consumption of animal products in particular is seen as a key control element in the development of a supranational sustainable food system (WBAE, 2020).

One contribution towards achieving these climate oriented goals could be increased consumer acceptance of a plant-based diet (WBAE, 2020; BMEL, 2021b). In this context, food-related behaviour represents a complex framework for action, since it is shaped by individual habits as well as by the social and cultural environment. Enhanced educational offers about climate relevance, sustainability and health promotion when focusing on plant-based diets may therefore provide targeted areas for political action, provided that the influencing factors that determine food consumption by the respective consumer groups are well understood.

In this context, a large number of studies have already addressed general consumer behaviour with regard to choices of plant-based substitutes for products of animal origin. For example, DEAN et al. (2008) demonstrated that food-related satisfaction is determined by individual goals associated with a certain diet and by the availability of certain foods. SCHYVER and SMITH (2005) examined consumer attitudes and beliefs about soy-based substitutes, focusing on the differences between consumers and non-consumers. They concluded that these two groups of people differ in their attitudes and that non-consumers give more weight to barriers related to taste or health than consumers of soy products (SCHYVER and SMITH, 2005). KONTTINEN et al. (2021) focused on socio-demographic differences to explain food choices and showed that consumers with lower incomes and lower levels of education attach more weight to product attributes, such as price and familiarity with the product, than to health or environmental attributes. HAAS et al. (2019) undertook a quantitative investigation of the general product image of plant-based dairy alternatives and combined these findings with a qualitative analysis of motives for the consumption of plant-based dairy substitutes in Austria. Their results show that the consumption decision is linked to individual beliefs and is consequently influenced by current trends and social debates. Furthermore, they showed that high prices and low availability of plant-based dairy products can become barriers to consumption (HAAS et al., 2019). GEBHARDT and HADWIGER (2020) identified that the motivation behind plant-based diets and plant-based food product consumption in part follows different motives and must therefore be distinguished.

This review of the literature shows that broader empirical evidence about what determines the decision to consume or not to consume PBDPs at the margin remains scarce.

The aim of this paper is therefore to understand the extent to which the relevance of the topic of sustainable nutrition has already reached consumers, using the consumption of plant-based milk substitutes as an example. The question addressed is whether factors such as environmental concerns, animal welfare and health aspects play a role in the consumption decision and can be viewed as profound drivers of it. Another objective is to identify the consumer groups and consumption aspects (influencing factors) that can be effectively addressed in the context of information provision and educational offers in order to promote sustainable nutritional behaviour. The following section presents expectancy-value theory as a behavioural model, using it here as the basis for understanding consumers' evaluation process with respect to decisions about whether to purchase PBDPs. Section 3 describes the data collection while section 4 presents the econometric model. In section 5 the results are presented and conclusions are given in section 6.

2 Theoretical Framework

To fill the gap in quantitative studies on consumer behaviour in the choice of PBDPs across Europe, the following analysis will identify possible influencing factors against the theoretical background of the expectancy-value theory. This is taking into account the aforementioned complex construct of belief formation that comes into play in decision-making process of consumers as reported by HAAS et al. (2019). It will also show the extent to which non-

consumers differ from consumers in their decision-making process, how this group can be convinced to buy, and how an increase in consumption can be achieved among the target group of consumers who already purchase these products.

According to expectancy-value theory, actions concerning consumers' purchase decisions are based on the individual assessment of the benefit, success and value of a certain buying activity. The assumed aim of the consumer is to maximise resulting benefits from consumption (WIGFIELD, 1994; ECCLES and WIGFIELD, 2002), e.g. the decision to substitute a certain product group with another or to include previously unconsumed products in the diet. In this context, the consumers' decision is driven by a vector of individual beliefs such that $i = 1, \dots, N$ individual consumers form $j = 1, \dots, J$ beliefs from a range of external influences, short-term experiences and evaluated information, as well as past knowledge that has remained in their memory. These individual beliefs then determine the general attitude (A_i) towards a topic. However, different aspects of these beliefs can also point in different directions in the decision-making process, thus creating a trade-off between different product attributes, which have to be weighed (w_{ij}) against each other (GRUNERT et al., 2014).

For example, attitudes towards environmental or animal welfare aspects can have a positive effect on the decision to consume plant-based dairy substitutes, while beliefs on taste or other product characteristics can have a negative effect if these characteristics do to match consumer preferences. Whether the sum of positive or negative opinions prevails or how individual influencing factors are weighted then determines the final consumption decision on the basis of the individual benefit assessment. Following AJZEN and FISHBEIN (2000), the formation of the consumers' long-term attitude $A_i$can therefore be described as follows:

(1) $$A_i = \sum_{i=1}^{n} \sum_{j=1}^{k} B_{ij} w_{ij}$$

An individual's existing beliefs this way influence the consumer's long-term attitude. The existing attitude towards products can be changed and adjusted in the short term by gaining information and knowledge (KEMPEN et al., 2017). If the origin of consumers' information-processing behaviour is questioned, this may be explained by psychology, which states that human behaviour is essentially determined by the opportunities to receive information, the individual motivation to obtain information, as well as the possibilities to process and evaluate this information. The three drivers of behavioural change can therefore be summed up to: motivation, ability and opportunity (GRUNERT et al., 2014).

It should be noted here that motivation and behaviour take on a strongly individual character, and therefore factors that can influence individual decisions must be taken into consideration, particularly when investigating the aspects that influence consumption decisions (ATKINSON, 1957). However, if consumers are strongly bound to personal habits and behavioural patterns in nutrition, they are less active about seeking out new information (VERPLANKEN and AARTS, 1999).

Hence, the value attribution leading to a particular consumption decision or the individual decision attributes that are considered in advance are based on personal incentives that motivate a consumption decision. For example, if there are strong intrinsic incentives to improve general health, it is conceivable that positive health aspects associated with the consumption of PBDPs will also be given greater weight in the decision-making process and will be a deciding factor (ECCLES and WIGFIELD, 2002). However, if a consumer is strongly embedded in a social structure or cultural habits that supports the consumption of animal products, this can create an incentive to decide against the consumption of PBDPs in order to conform with the norms of this structure.

Based on this framework, the following research hypotheses were derived concerning the decision among different consumer groups to purchase PBDPs and their food-related behaviour:

H1: The decision factors of PBDP consumers and non-consumers differ. Drivers of consumer frequency of consumption can be separated out from the general decision about whether to consume these products or not.

H2: The group that already consumes PBDPs is more sensitive to ecological, health and animal welfare concerns and therefore has an information advantage over non-consumers.

H3: Active engagement with the topic of plant-based milk substitutes and related information gathering leads to a greater willingness to consume.

3 Data

In order to test these hypotheses, Europe-wide data collection was carried out in France, Italy, Spain, Denmark, Poland and Germany. The sample used for the analysis here comprised 3086 responses from a cross-sectional survey based on quoted sampling (age, sex, nutrition style, consumption habits) and a country split of N=500.

Respondents were selected and included in the sample if they either consumed PBDPs already or belong to a consumer group that shows interest in these types of products but are not currently actively consuming them. The sample can therefore only be considered representative to a limited extent, as non-consumers who have not yet shown interest in consuming dairy substitutes are not represented. However, the analysis of the dataset offers an opportunity to gain initial insights into differences between consumers and the section of non-consumers who are at least "interested in dairy alternatives" and their motives for (not) buying PBDPs.

It is assumed that the dietary style of the consumers influences their willingness to consume PBDPs (GEBHARDT and HADWIGER, 2020). Therefore, consumers can be assigned to different groups and a differentiation based on their dietary style can be defined as follows: omnivores include all consumers who consume meat and animal products without restrictions; flexitarians are defined as people who consume animal products, but have a heightened awareness of their consumption and therefore actively reduce it and temporarily abstain from animal products; the group of vegetarians who abstain from meat and fish, or in the case of pescetarians exclude only meat from their diet; and vegans who, in contrast to vegetarians, also abstain from all products of animal origin, including dairy products (DGE, 2013). Through the explanatory variable "dietary style", participants' current dietary style was assessed by self-assignment. For the econometric estimation, it was assumed that dietary style can be ordered in terms of the degree to which animal products are restricted, and that more restrictive diets promote a greater willingness to consume plant-based substitutes as there is a greater need for substitution of animal products. Accordingly, it was hypothesised that vegans are more likely to consume PBDPs at a greater frequency than flexitarians or omnivores, for example.

The data for the analysis were collected as part of the project "The V-PLACE – Enabling consumer choice in vegan or vegetarian food products", which is funded by EIT Food, the food innovation community of the European Institute of Innovation and Technology (EIT). The survey aimed to map consumer preferences in relation to the consumption of plant-based dairy and meat substitutes.

4 Methodology

4.1 Econometric estimation strategy

The dependent variable examined in this analysis was the frequency of consumption of PBDPs per respondent within a time range of one month. In the survey on which the data are based, this variable was ordinally scaled from 1 ("never") over 2 ("Less than once a month"), 3 ("Once a month"), 4 ("Several times a month"), 5 (" Once a week"), 6 ("Several times a week") to 7 ("daily") and describes therefore if the consumption habit can be stated as occasional, regular

or even habitual. In order to answer the question about which explanatory variables have an influence on this reported frequency of consumption and the extent of the factors' respective effect, an ordered probit model was used. The application of the econometric model is based on the theoretical model of expectancy-value theory, in which a consumption decision of the individual Y_i (for $i = 1, \dots, N$ individuals in the sample) is based on the prevailing attitude a towards a product. The attitude is formed from the sum of the prevailing weighted beliefs according to Eq. 1 (AJZEN and FISHBEIN, 2000). According to Eq. 1, the vector of individual beliefs, $\boldsymbol{B}$, is formed from j possible factors influencing a consumer's decision-making behaviour and opinion formation. For the empirical implementation in the econometric estimation strategy, this vector $\boldsymbol{B}$ is disaggregated into more specific vectors as group factors influencing the consumption decision and consumption frequency of individual i in respective belief categories K, P, D, S, E (in the following denoted by the subscripts):

$$B_i = f(B_{iK} + B_{iP} + B_{iD} + B_{iS} + B_{iE}) \quad (2)$$

These include individual experiences gained from past consumption activities, as well as prevailing opinions on health and ethical aspects, resulting in existing knowledge and processed information with regard to the product group under consideration (B_K). The evaluation of direct product characteristics (B_P), such as the price or availability of the considered products play another role in the formation of the general attitude. In addition, socio-economic and socio-demographic factors (B_s) and the beliefs accompanying their current diet (B_D) influence individual attitudes. External influences also have an impact on prevailing beliefs. These include topics that are evaluated by society and brought to the individual's attention, such as aspects of animal welfare, social justice or sustainable production processes currently being debated. Furthermore, the social environment and its attitude towards certain diets and associated consumption influence individual attitudes (B_E). Depending on how strongly the presence of individual influencing factors affects a person's beliefs, the consumption decision and thus the acceptance of the considered products are influenced in certain directions.

When modelling the influence of the individual factors, it can be assumed that there is a systematic difference between people who already consume PBDPs and potential consumers who are interested but have not yet actively decided to consume them. This difference was taken into account by an extended ordered probit (eoprobit) model, using a selection equation to characterise the group of non-consumers in order to counteract the sample selection problem and correct the bias caused by systematic differences between consumers and non-consumers (HECKMAN, 1979). The selection equation as the first part of a two-equation system is presented as follows:

$$Y_i = \alpha_0 + \gamma_K B_K + \gamma_P B_P + \gamma_D B_D + \gamma_S B_S + \gamma_E B_E + \eta_i \quad (3)$$

with $Y_i = 1$ in the decision to consume PBDPs. The ordered probit regression equation formally takes the following form:

$$Y_i^* = \alpha_0 + \gamma_K B_K + \gamma_P B_P + \gamma_D B_D + \gamma_S B_S + \gamma_E B_E + \eta_i + \beta_K B_K + \beta_P B_P + \beta_D B_D + \beta_S B_S + \beta_E B_E + \varepsilon_i \quad (4)$$

The first part, $\gamma' \boldsymbol{B}$ with the error term η_i, represents the selection process of PBDP consumers and non-consumers. The second part, $\beta' \boldsymbol{B}$ with the error term ε_i, represents the explanatory process of consumers' consumption frequency of plant-based dairy substitutes. The vectors of the regressors $\boldsymbol{B}$ consist of the factors influencing the consumers' belief according to Eq. 1. The dependent variable $Y_i^* = \{0, \dots, 7\}$ represents the consumption frequency for PBDPs and takes on a certain value v_i from the sum of the ordered categories $M = 1, \dots, m$ if the estimated function according to Eq. 4 takes a certain value between two threshold values (cut points c_m). The probability that a certain consumption frequency is chosen by a consumer is thus given as (CAMERON and TRIVEDI, 2009; HECKMAN, 1979):

(5) $\Pr(Y_i^* = v_i) = \Pr(c_{m-1} \leq \beta' \boldsymbol{B} + \gamma' \boldsymbol{B} + \varepsilon_i + \eta_i \leq c_m)$

The cumulative probability distribution of a probit model is assumed to be standard normally distributed, so that the probability of the frequency of consumption taking on a certain value is distributed between 1 and 0 as follows (CAMERON and TRIVEDI, 2009; WOOLDRIDGE, 2010):

(6) $Pr(Y_i^* = v_i) = \int_{-\infty}^{\beta' \boldsymbol{B} + \gamma' \boldsymbol{B}} \phi(z) dz = \phi(\beta' \boldsymbol{B} + \gamma' \boldsymbol{B})$

4.2 Marginal effects

Estimated regression coefficients from both a binary and an ordered probit model can only be interpreted to the limited extent of the direction (positive or negative) of the effect. It is not possible to interpret the magnitude of the estimated coefficient. In other words, due to the assumed cumulative normal distribution of the probability, the estimated coefficients indicate the variation of the distribution function (WOOLDRIDGE, 2010, p. 581). However, no conclusions can be drawn about the effect size. For a more detailed interpretation, the calculation of marginal effects as a measure of the variation of consumption frequency probabilities is a suitable strategy. The marginal effects indicate the change of the dependent variable due to a small – i.e. marginal – change in the respective explanatory variable. This allows an examination of the extent to which, for example, an increased weighting for the relevance of the price of a plant-based substitute product (e.g. on an ordinal scale from "not important" to "very important") has an effect on the increase or reduction in consumption frequency and can therefore be interpreted as the weighting factor w_{ij} that weights several belief attributes according to Eq. 1. Formally, the marginal effect of an influencing factor on a multivariate variable $f(y) = f(y_1, \dots, y_M)$ takes the following form (CAMERON and TRIVEDI, 2009):

(7) $\frac{\partial \Pr(y_i = m)}{\partial x_{ri}} = \phi(x'\beta)\beta_i = \{F'(\alpha_{m-1} - x'_i\,\beta) - F'(\alpha_m - x'_i\,\beta)\}\beta_r = \frac{\partial \Pr(y_i = m)}{\partial \sum_{i=1}^{n} \boldsymbol{B}_i w_i}$

In econometric applications, however, the term "marginal effects" is used in a variety of ways for different effect estimates. In the analysis below, the method of average marginal effects (AME) is used, which allows an investigation of average changes in consumption frequency when the observed explanatory variable changes by one unit (BARTUS, 2005). The estimation of the extended ordered probit model and the marginal effects was carried out with STATA 17 (2021) using the *eoprobit* and *margins* command.

5 Results

5.1 Descriptive Statistics

In addition to the consumption frequency used as dependent variable for the ordered probit model, a consumption dummy that indicated whether a person generally consumes PBDPs or not was the dependent variables of central interest for the selection process within the estimation. There were almost 300 non-consumers in the sample, making up 10 % of the sample.

The majority of the respondents (69.09 %) described themselves as omnivorous, whereas 21.06 % of the respondents stated that they were flexitarians. A comparison of the diets represented in the sample and their proportions with the current distribution of diets in Europe revealed that the present sample was approximately representative of the distribution in Europe 2020 (see Table 1). Here, reference is made to the results of the Veganz Nutrition Report 2020, which recorded the nutritional behaviour of the European population. Only the proportion of vegetarians and pescetarians in the sample was above the European average, whereas the proportion of flexitarians was slightly below it (VEGANZ GROUP AG, 2020).

Table 1: Comparison of the sample distribution with the current distribution of dietary styles in Europe

Dietary style	Europe (%)*	Sample (%)
Omnivore	69.1	69.09
Flexitarian	22.9	21.06
Vegetarian	2.9	4.5
Vegan	1.9	1.36
Pescetarian	2.9	3.99

Source: *VEGANZ GROUP AG, 2020, own presentation

In the sections below, the consumer profile of non-consumers is depicted in order to show the characteristics that make up the group of people who are interested but not yet consuming these products and to distinguish them from consumers already purchasing PBDPs. Furthermore, the marginal effects of individual explanatory variables on the probability of deciding to consume PBDPs and on a particular frequency of consumption will be discussed.

5.2 Exploratory factor analysis

In order to confirm the suspected endogenous sample selection problem, the correlation of the error terms of the selection equation and the main equation was examined first (CAMERON and TRIVEDI, 2009, p. 557). A significant correlation could be confirmed here (p-value = 0.016), indicating the appropriateness of the estimation method.

The dataset included two questions that explicitly targeted factors that influence consumption of PBDPs. First, respondents were asked how important various factors concerning the product, the social environment and the individual attitude were estimated to be in the decision to purchase a product in general. Second, respondents were asked for a specific evaluation of various factors as obstacles to the purchase of PBDPs. These two questions consisted of 18 and 19 individual attributes respectively. In order to avoid multicollinearity among the explanatory variables, an exploratory factor analysis was carried out for these two questions for the purposes of dimension reduction. This resulted in a reduction to three variables that summarised the most important factors influencing the purchase decision. The factor analysis clearly showed that the first factor concerns the product characteristics themselves (factor "Product characteristics"). Another factor includes topics that are debated in society, such as environmental protection, animal welfare, social ethics and sustainability aspects (health, ethics, environment = "HEE"-factor). In addition, the factor "Social norms" played a role and included the consumer's socio-cultural embeddedness. The question concerning barriers of consumption was defined most appropriately through a two-factor solution. One factor was formed from potential barriers with respect to product characteristics (factor "Barriers with respect to product characteristics"). Here, the availability, sensory characteristics and price of the product were taken into account. The second factor included all other variables and could therefore be considered as a general obstacle factor with various social, normative and societal hurdles (factor "Barriers with respect to social environment"). Included in the factor were extended product characteristics, such as the salt content, degree of processing, concerns with respect to intolerances and nutritional content. It was therefore possible to interpret these as influencing factors that consumers perceive to be hurdles when they increasingly deal with the product properties of PBDPs taking the social environment into account. Consideration of the Kaiser-Meyer-Olkin (KMO) measure showed that the factor analysis both for influencing factors and barriers had an average value of 0.93 and 0.97 respectively, underlining the suitability of the data for a factor analysis. For this reason, the eoprobit model was set up with the formed index variables of the extracted factors, with weighting by the respective factor loadings.

5.3 Results of the extended ordered probit model

Socio-demographic and socio-economic factors as well as overall consumer attitudes towards the product group had an influence on the general decision about whether to consume plant-based products or not. The results of the eoprobit model showed that the dietary style had a significant influence on the consumption decision. According to this, vegans are almost 10 % more likely and vegetarians 7 % more likely to consume PBDPs than omnivores. This percentage change represents the marginal effects of the dietary style. Due to space limitations, the effects are not reported in Table 2 along with the estimation results. With increasing age, however, consumers are less likely to consume PBDPs. Therefore, the current consumer group of plant-based dairy substitutes can be described as young. In the age group of 20-year-old respondents, the likelihood of consumption was 6 % greater than among 60-year-olds. However, if PBDPs are already consumed, age no longer had a significant influence on the frequency of consumption. It can therefore be assumed that once people have made the decision to buy PBDPs, age has no effect on whether use is regular or occasional. On the overall decision whether to consume PBDPs or not gender has no effect but the results show that women decide to use PBDPs less frequently compared to other genders. This result deviates from existing research papers, which report that female consumers in particular are more likely to pursue a vegan or vegetarian lifestyle and are also more likely to purchase PBDPs (HAAS et al., 2019; JANSSEN et al., 2016).

Children living in the household also have a positive effect on the consumption decision in favour of PBDPs (see Table 2, upper part). It can therefore be assumed that young families with children in particular are increasingly replacing animal dairy products with plant-based alternatives. The level of education, however, had no significant effect on the general consumption decision, but did have an influence on the frequency of consumption in the group of people who already consume (see Table 2, bottom row: level of education). Here, a positive correlation between a higher level of education and the frequency of consumption is shown. The highest marginal effect of the educational level concerned the probability of weekly use. Here, a doctoral degree increases the probability of consumption by 4 % compared with people who have no degree or no qualifications beyond high school or middle school.

Perceived product characteristics also influenced decision-making behaviour with regard to PBDPs. Consumers who have higher demands on the product characteristics of plant-based dairy alternatives, i.e. want a greater variety, a higher nutrient content and an improved eating experience, were more critical of the consumption decision and less likely to consume these products on a higher frequency. Considering e.g. sensory characteristics of PBDPs it is assumed that consumers choose the relevance as determinants of non-consumption based on existing prejudice and decision frames that formed specific beliefs. Therefore, they haven't experienced e.g. the taste directly but rather have pre-existing negative beliefs due to biased media or social environment, and this may bias their perception with regard to the consumption of PBDPs as well. Product characteristics (factor "Product characteristics") also played a role for consumers that actively use PBDPs, but to a differing extent than for non-consumers. Therefore, hypothesis H1 is not rejected, as differences in the influence on decision-making behaviour can be seen here, as identified already in relation to consumers' level of education. The more important these product attributes are to consumers, the greater the probability to consume PBDPs several times a week or even daily (of 2.5 and 3 %). However, if consumers see the attributes that make up the product characteristics of plant-based dairy products as an obstacle or challenge to (increased) consumption, the frequency of consumption is also reduced (see Table 2, negative sign coefficient "Barriers product characteristics"). This result is similar to the results of the

Veganz Nutrition Report, which points to an increased desire among consumers to have a wider selection of plant-based dairy product alternatives (VEGANZ GROUP AG, 2020).

Table 2: Results of the extended ordered probit model

Variable	**Belief attri-butes**	**Coefficient (significance level)**
Independent variables		**Dep. variable: Consumption of PBDPs yes/no**
Dietary style	B_D	0.234(***)
Age	B_S	-0.010(***)
Gender = female	B_S	-0.186(*)
Active information gathering	B_K	0.912(***)
Wish for better taste of PBDPs	B_P	-5.404(***)
Wish for a better mouthfeel of PBDPs	B_P	-5.493(***)
Wish for higher nutrient content PBDPs	B_P	-0.519(*)
Wish for greater variety of PBDPs	B_P	-0.803(***)
Household with children	B_S	0.109(*)
Level of education	B_S	0.020
Wish for uniqueness of a product	B_P	0.299(*)
Wish for information on the origin of a product	B_K	-0.155
Wish for environmentally friendly product	B_E	-0.178
Satisfaction of taste preferences	B_P	-0.223(**)
Germany	B_S	-0.029
Spain	B_S	0.061
Poland	B_S	0.053
Denmark	B_S	-0.237
Constant	B_S	12.523
Independent variables		**Dep. variable: Consumption frequency of PBDPs**
Consumption plant-based meat products	B_D	0.240(***)
Price of a product	B_P	-0.07(*)
Influencing factor “Social norms”	B_E	0.065 (p-value = 0.052)
Influencing factor “Product characteristics”	B_P	0.174(**)
Influencing factor “HEE”*	B_E	0.089(*)
Barriers with respect to product characteristics	B_P	-0.165(***)
Barriers with respect to social environment	B_E	0.030
Active information gathering	B_K	0.134(*)
Shopping in organic supermarkets	B_S	0.116(*)
Age	B_S	-0.002
Level of education	B_S	0.035(**)
Germany	B_S	-0.430
Spain	B_S	-0.280
Poland	B_S	-0.317
Denmark	B_S	-0.394
Italy	B_S	-0.309
Correlation of errors		**-0.245(**)**
Significance levels: * p<0.05; ** p<0.01; *** p<0.001		

Source: Own estimation results. *HEE factor = Health, ethics, environment factor.

If it is important to consumers that the product they buy has been produced in accordance with environmental standards, they are more likely to refrain from consuming PBDPs. This could be related to a prevailing negative attitude towards soy cultivation, as dairy product substitutes are

often associated with substitution by soy (SCHYVER and SMITH, 2005; ALLEN et al., 2018). Another statistically significant influence on consumption frequency is the regular consumption of plant-based meat products, which has a marginal effect to increase the probability for a weekly consumption of plant-based dairy products by almost 35 %. This confirms that people who generally opt for alternatives to animal derived products increase their consumption of substitute products and try to implement this in as much of their diet as possible. This suggests that consumers who are generally open-minded about plant-based substitute products are increasingly turning to substitute products in several food groups as meat and dairy products in our case. However, the more important the price of a product is to active consumers of PBDPs, the less frequently they choose it.

The index variables formed from the factor analysis on influential aspects in product choice were statistically significant in each case. The variable "Social norms" was only weakly significant, with a p-value of 0.052. Characteristics concerning the product quality and exogenous influences, such as animal welfare or sustainability ("HEE"-factor), however, had a significant positive effect on the frequency of consumption. It can therefore be concluded that PBDPs are seen as sustainable and compatible with animal welfare aspects and social justice, and that it is worthwhile emphasising these product characteristics in advertising messages. In addition, health concerns have an impact on consumption decisions. Therefore, H2 cannot be rejected. People who actively seek out information on plant-based substitute products, i.e. search for information on this product group and thus actively try to close knowledge gaps, are also more likely to consume PBDPs. Thus, hypothesis 3 is not rejected. The lack of consumption so far can therefore be explained, at least in part, by a lack of knowledge about plant-based dairy alternatives e.g. concerning product characteristics or health and environmental benefits. If consumers actively obtain information due to curiosity or overall increased interest, the probability of consuming PBDPs increases by 12 %. Active information procurement also has an influence on increasing the consumption frequency of people who already consume.

Taking differences between the observed countries into account, dummy variables were included. Taking France as a reference country, the results showed that the consumer's home country has no effect on consumption habits. Strategies to promote sustainable nutrition can therefore be transferred from national to supranational levels.

6 Discussion and Conclusions

In summary, it can be deduced from the results that both the decision whether or not to buy PBDPs and consumers' consumption frequency of PBDPs are subject to a variety of potential influencing factors, i.e. beliefs that determine the attitude and reservations of consumers who are at the margin between non-consumption and consumption of PBDPs. One factor that positively influences both the decision to consume and the consumption frequency of those who already consume is active information gathering. This effect highlights that when consumers are engaged with the topic of nutrition and show a willingness to explore the potential advantages and disadvantages of different diets and product innovations, they are less biased about plant-based alternative products, have fewer reservations, and are willing to reconsider existing beliefs and adjust their attitudes. Therefore, it is necessary to raise awareness of hesitant and reluctant consumers about the benefits of PBDPs and adjust existing attitudes to the products if the goal of policy makers is to change the European food system.

Increasing the availability of tailored information on plant-based dairy substitutes is therefore an important factor in attracting new customers and retaining existing ones. There also seems to be uncertainty among some non-consumers about the environmental compatibility and nutritional composition of such products. This shows that potential consumers are deterred from

purchasing the products if the nutritional composition of products plays a role in their purchase decision and if the ecological footprint is unknown.

The consumer group of previously uninterested consumers is absent from the present sample because the intention was to focus on consumers who are relatively 'close' to the marginal decision of whether or not to consume these products. However, the country specific effects have only been taken into account as Dummy variables, so that a more precise investigation of potential heterogeneity across countries would have to be left to future research. The same holds for an analysis of the group of consumers who are not at all interested in PBDPs.

Literature

AJZEN, I. and M. FISHBEIN (2000): Attitudes and the Attitude-Behavior Relation: Reasoned and Automatic Processes. In: European Review of Social Psychology 11 (1): 1–33.

ALLEN, S., E. GODDARD and A. FARMER (2018): How knowledge, attitudes, and beliefs impact dairy anti-consumption. In: British Food Journal 120 (10): 2304–2316.

ATKINSON, J. W. (1957): Motivational determinants of risk-taking behavior. In: Psychological review 64, Part 1 (6): 359–372.

BARTUS, T. (2005): Estimation of marginal effects using margeff. In: Stata Journal 5 (3): 309-329(21).

BMEL (2021a): Deutschland, wie es isst. Der BMEL-Ernährungsreport 2021. Bundesministerium für Ernährung und Landwirtschaft.

BMEL (2021b): Konzept zur Förderung einer nachhaltigen Ernährung. Bundesministerium für Ernährung und Landwirtschaft. In: https://www.bmel.de/DE/themen/ernaehrung/nachhaltiger-konsum/konzept-nachhaltige-ernaehrung.html. Latest access: 17.2.2022.

CAMERON, A. C. and P. K. TRIVEDI (2009): Microeconometrics Using Stata. Stata Press.

DEAN, M., K. G. GRUNERT, M. M. RAATS, N. A. NIELSEN and M. LUMBERS (2008): The impact of personal resources and their goal relevance on satisfaction with food-related life among the elderly. In: Appetite 50 (2): 308–315.

DGE (2013): Deutsche Gesellschaft für Ernährung: Flexitarier - die flexiblen Vegetarier. Deutsche Gesellschaft für Ernährung, DGEinfo. In: https://www.dge.de/wissenschaft/weitere-publikationen/fachinformationen/flexitarier-die-flexiblen-vegetarier/. Latest access: 27.1.2022.

ECCLES, J. S. and A. WIGFIELD (2002): Motivational Beliefs, Values, and Goals. In: Annual Review of Psychology 53 (1): 109–132.

GEBHARDT, B. and K. HADWIGER (2020): Plant-based foods for future: Results of consumer and professional expert interviews in five European countries, EIT-Food Project "The V-Place". Agricultural Economics Working Paper. No. 29, Institute of Agricultural Policy and Markets, University of Hohenheim, Stuttgart.

GRUNERT, K. G., S. HIEKE and WILLS JOSEPHINE (2014): Sustainability labels on food products: Consumer motivation, understanding and use. In: Food Policy 44: 177–189.

HAAS, R., A. SCHNEPPS, A. PICHLER and O. MEIXNER (2019): Cow Milk versus Plant-Based Milk Substitutes: A Comparison of Product Image and Motivational Structure of Consumption. In: Sustainability 11 (18).

HECKMAN, J. J. (1979): Sample Selection Bias as a Specification Error. In: Econometrica 47 (1): 153–161.

JANSSEN, M., C. BUSCH, M. RÖDIGER and U. HAMM (2016): Motives of consumers following a vegan diet and their attitudes towards animal agriculture. In: Appetite 105: 643–651.

JESKE, S., E. ZANNINI and E. K. ARENDT (2018): Past, present and future: The strength of plant-based dairy substitutes based on gluten-free raw materials. In: Food Research International 110: 42–51.

KEMPEN, E., J. KASAMBALA, L. CHRISTIE, E. SYMINGTON, L. JOOSTE and T. VAN EEDEN (2017): Expectancy-value theory contributes to understanding consumer attitudes towards cow's milk alternatives and variants. In: International Journal of Consumer Studies 41 (3): 245–252.

KONTTINEN, H., O. HALMESVAARA, M. FOGELHOLM, H. SAARIJÄRVI, J. NEVALAINEN and M. ERKKOLA (2021): Sociodemographic differences in motives for food selection: results from the LoCard cross-sectional survey. In: International Journal of Behavioral Nutrition and Physical Activity 18 (1): 71.

SCHYVER, T. and C. SMITH (2005): Reported Attitudes and Beliefs toward Soy Food Consumption of Soy Consumers versus Nonconsumers in Natural Foods or Mainstream Grocery Stores. In: Journal of Nutrition Education and Behavior 37 (6): 292–299.

SMART PROTEIN PROJECT (2020): Plant-based foods in Europe: How big is the market? Smart Protein Plant-based Food Sector Report by Smart Protein Project. European Union's Horizon 2020 research and innovation programme. Smart Protein.

STATA 17 (2021): Stata Statistical Software. Release 17. StataCorp, College Station, TX.

STEHFEST, E., L. BOUWMAN, D. P. VAN VUUREN, M. G. J. den ELZEN, B. EICKHOUT and P. KABAT (2009): Climate benefits of changing diet. In: Climatic Change 95 (1): 83–102.

VEGANZ GROUP AG (2020): Vengaz Ernährungsreport 2020. Veganz Group AG.

VERPLANKEN, B. and H. AARTS (1999): Habit, Attitude, and Planned Behaviour: Is Habit an Empty Construct or an Interesting Case of Goal-directed Automaticity? In: European Review of Social Psychology 10 (1): 101–134.

WBAE (2020): Politik für eine nachhaltigere Ernährung. Eine integrierte Ernährungspolitik entwickeln und faire Ernährungsumgebungen gestalten. Gutachten. Wissenschaftlicher Beirat für Agrarpolitik, Ernährung und gesundheitlichen Verbraucherschutz beim Bundesministerium für Ernährung und Landwirtschaft, Berlin.

WIGFIELD, A. (1994): Expectancy-value theory of achievement motivation: A developmental perspective. In: Educational Psychology Review 6 (1): 49–78.

WOOLDRIDGE, J. M. (2010): Econometric analysis of cross section and panel data. MIT Press, Cambridge, Massachusetts, London, England.