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No Cow? Understanding US Consumer Preferences for Plant-Based over Regular Milk-Based Products

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Abstract: Dairy products such as cheese, butter, and yoghurt are popular staples in American households; however, alternative plant-based products are gaining increasing popularity. An online survey was conducted to investigate the factors that determine US consumers' preferences for plant-based and regular milk-based products before and since the occurrence of food price inflation. The study used descriptive statistics and partial least square structural equation modelling for the analysis. The accessibility of plant-based substitutes, the perceived impact of food price inflation and associated consumer behaviour, engagement with food-related activities, and environmental concerns were important factors in both scenarios. Recommendations to marketers on how to target different consumer groups are offered.

Keywords: plant-based milk alternatives; PLS-SEM; environmental impact; food price inflation



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1. Introduction

Dairy production has a longstanding tradition in US agriculture, and regular milk and other dairy products such as cheese, butter, and yoghurt are popular staples in American households [1–3]. National campaigns such as “Got Milk”, as well as school lunch initiatives, promoted the nutritional importance of regular milk and milk-based products [1,4]. Despite the efforts of governments and the agricultural industry to advertise these products, the per capita consumption of regular milk has been decreasing since the 1980s, and with increased intensity in the past decade [2]. The availability of plant-based alternatives to regular milk and dairy products can be attributed to this trend [5–7]. In 2021, plant-based milk alternatives were an important contributor in the US plant-based food market, with a sales value of approximately USD 2.800 million, including the most popular plant-based milk brands, Silk and Blue Diamond. The value of plant-based yoghurt, cheese, and butter totalled USD 881 million [8,9].

Important factors that are driving the switch from regular to plant-based product alternatives are increased health and sustainability awareness among US consumers [10]. Part of this increased health awareness comes from an increasing body of knowledge on the impact of lifestyle, particularly in relation to diet, physical activities, and environmental exposure, on human health [11]. Research in nutrigenomics, or the study of the effect of food and food components on the expression of the human genome, have exposed consumers to more knowledge on the pathways through which dietary components interact with the human digestive system [11]. While the effects of a plant-based diet on human health are by no means conclusive, the old saying of “you are what you eat” has become ever more persuasive. Health concerns related to regular dairy products in recent studies include lactose intolerance, high cholesterol, the transmission of zoonotic diseases, microbial resistance, and concerns associated with hormones in regular milk [10,12,13]. Sustainability-related concerns include carbon emission, biodiversity, animal cruelty, slaughter, and on-farm welfare, as well as environmental externalities associated with dairy production [14–16].

Factors hindering the consumption of plant-based product alternatives include food neophobia, low income, and the comparatively higher price point of these products [16–20].

The latter is of increasing relevance as food prices have dramatically increased as the US experiences ongoing food price inflation. Recent reports evaluating US consumers' food purchases indicate that buying behaviour has been adjusted to these circumstances, primarily to save money [21–25]. To contribute to a more comprehensive understanding of consumer preferences for plant-based milk and dairy alternatives, the purpose of the present study is to model the factors that determine the preferences for plant-based product alternatives compared to regular dairy products in two scenarios, namely before the occurrence of food price inflation and since the occurrence of food price inflation in the US. Potentially relevant factors are thought to be perceptions and attitudes related to cost, food price inflation, engagement with food, and environmental concerns, which are discussed in the upcoming section of the manuscript. Aligned with the literature review on these predictors, hypotheses and a proposed conceptual model have been developed (see Figure 1).

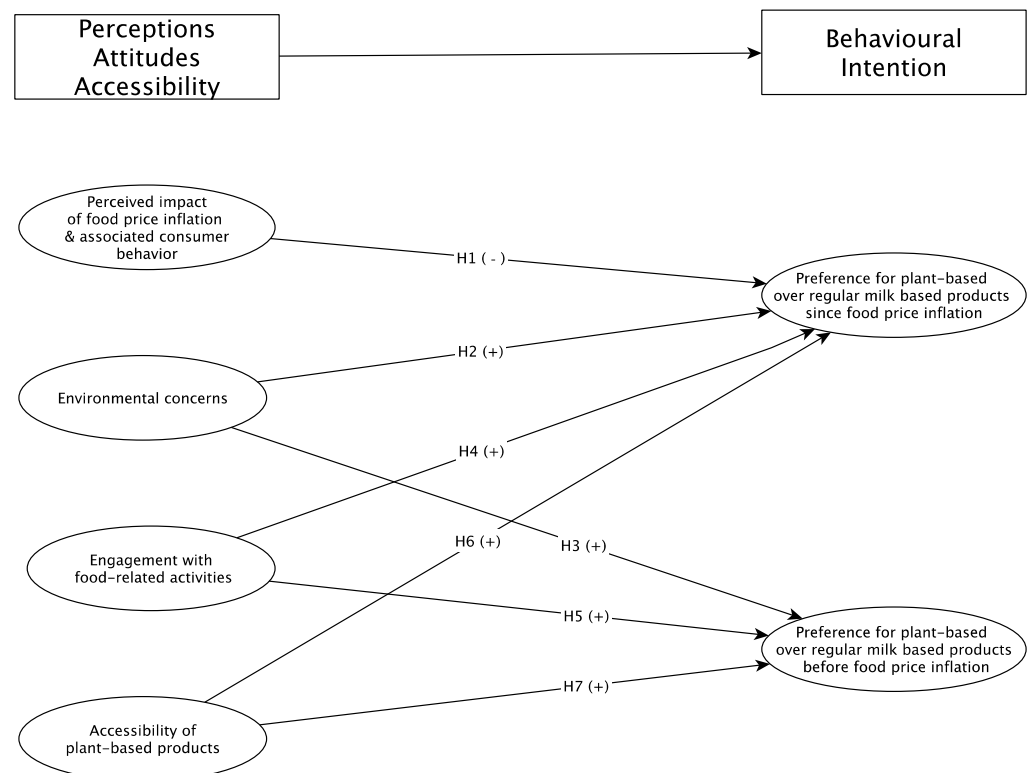


Figure 1. Proposed conceptual model.

2. Conceptual Framework and Hypotheses

2.1. Perceived Impact of Food Price Inflation and Associated Consumer Responses

Recent studies report reasons for food price inflation and consumer responses to increased food prices in the US [25]. Food price inflation have been attributed to the coronavirus pandemic and consumption changes in favour of eating at home instead of going out [24–26]. Other reasons include the Russia–Ukraine war and the boycott against Russia, as well as an ongoing drought in the United States and a series of foodborne illnesses [26,27]. Recent research indicates changes in the food baskets of US consumers, including more basic and off-brand product options [22,23]. In addition, consumers are reported to have engaged in bulk buying and panic buying, often as responses to stress associated with growing uncertainties [22,23,25,28]. Amidst the background of the reported changes in consumer behaviour and the fact that plant-based products are costlier than regular milk-based products, the following hypothesis is proposed:

Hypothesis 1 (H1). *The perceived impact of food price inflation negatively affects US consumers' preferences for plant-based alternatives over regular milk-based products since the occurrence of food price inflation.*

2.2. Environmental Concerns

Plant-based milk and dairy alternatives are often advertised as being more environmentally friendly product options compared to milk-based products, as dairy production is associated with adverse effects on the environment [12,29]. These include soil degradation, greenhouse emissions, water pollution, and diminishing biodiversity [30,31]. As these issues are of concern for ethically and climate-conscious consumers who have been demanding movement towards more environmentally friendly food options and transparency concerning food production [12], retailers are selling food and beverages with sustainability certification and environmental product declarations [32,33]. These product declarations provide the consumer with information on the product's ecological impact such as its carbon footprint. Given this background, the following hypotheses are proposed:

Hypothesis 2 (H2). *Environmental concerns positively affect US consumers' preferences for plant-based alternatives over regular milk-based products since the occurrence of food price inflation.*

Hypothesis 3 (H3). *Environmental concerns positively affected US consumers' preferences for plant-based alternatives over regular milk-based products before the occurrence of food price inflation.*

2.3. Engagement with Food-Related Activities

Engagement with food-related activities such as home and community gardening, food foraging, food processing, cooking, and eating are important predictors of food-related consumer behaviour, as studies on alternative forms of food procurement and consumer preferences show [34,35]. In addition to these active hands-on food-related actions, passive forms of engagement are also important predictors. These include watching YouTube videos on food production and preparation and reading cookbooks [34]. Since the coronavirus pandemic and its impact on US food retail, including the disruptions of supply chain grids and food price inflation, engagement with food-related activities has increased in relevance for US consumers [34,35]. Active and passive engagement with food has become more important, and this knowledge has increased its influence on consumer food choices. Thus, the following hypotheses are proposed:

Hypothesis 4 (H4). *Engagement with food-related activities positively affects US consumers' preferences for plant-based alternatives over regular milk-based products since the occurrence of food price inflation.*

Hypothesis 5 (H5). *Engagement with food-related activities positively affected US consumers' preferences for plant-based alternatives over regular milk-based products before the occurrence of food price inflation.*

2.4. Accessibility of Plant-Based Substitutes

When consumers make choices, they consider benefits and costs in their evaluation of products and their attributes [36]. This evaluation considers food usage and functionality as benefits, as well as whether consumers have access to and can afford the product [36,37]. Money, effort, and time spent related to purchase and consumption are taken into consideration when evaluating the costs [36]. Plant-based milk alternatives are often products with high price points, and their retail availability can be limited to specialty food stores [11,28]. Previous research has shown that many consumers are unfavourably unwilling to spend more money or time on buying plant-based food products, despite understanding and valuing their benefits [13,29,38]. Hence, the following hypotheses are proposed:

Hypothesis 6 (H6). *The accessibility of plant-based alternatives positively affects US consumers' preferences for plant-based alternatives over regular milk-based products since the occurrence of food price inflation.*

Hypothesis 7 (H7). *The accessibility of plant-based alternatives positively affected US consumers' preferences for plant-based alternatives over regular milk-based products before the occurrence of food price inflation.*

Based on the presented literature review, a conceptual model is proposed (Figure 1). It is suggested that US consumers' preferences for plant-based alternatives over regular milk-based products, before and since food price inflation, are affected by the accessibility of plant-based substitutes, engagement with food-related activities, and environmental concerns. Since the occurrence of food price inflation, it is assumed that the perception of food price inflation is an additional relevant predictor.

3. Material and Methods

3.1. Survey and Sampling

The data used in this analysis were collected in December 2022 using a survey instrument, facilitated through the online survey tool Qualtrics XM. The survey aimed to understand consumer preferences for traditional dairy products and plant-based alternatives. Additional topics included consumer attitudes towards these products, attitudes towards and the perceived impact of food price inflation, and socio-demographic information. The questionnaire was developed based on the extant literature [12,13,22,23,34,39–41].

To participate in the study, the surveyed consumers had to be adults (≥ 18) and US residents. Also, any potential respondents who indicated not being in charge of household shopping or not having any interest or experience purchasing and consuming plant-based milk alternative products were excluded from the survey.

Access to the survey link was provided to registered workers on the crowd-sourcing platform Amazon Mechanical Turk (Mturk) [42]. Fifteen Mturk workers pretested the survey to ensure an error-free setup and the clarity of the survey items and instructions. In addition, the pre-test established completion time norms [43,44]. Any respondents who submitted the survey well before the average completion time of 15 min were omitted from the survey as it was assumed they executed fraudulent survey behaviour [45]. This produced 500 responses, but 14 were excluded for incompleteness and/or speeding behaviour. The resultant sample size of 486 US consumers was considered more than appropriate for the analysis aiming at factors driving consumer preferences via partial least squares structural equation modelling (PLS-SEM). This estimation is based on Hair's ten-times rule [46], a widely accepted minimum sample size procedure in the PLS-SEM community [46].

3.2. Analysis

Two statistical applications were employed: SPSS 28 for data coding, cleaning, and sample description, and SmartPLS 4 to perform the PLS-SEM analysis. The PLS-SEM approach first examines the measurement (outer) model then the structural (inner) model [43].

The purpose of the outer model examination is to check that the scales and their items used in a model have been accurately and reliably measured [47]. Hair et al. (2022) propose a series of tests including assessments of convergent validity via item/scale factor loadings and average variance extracted (AVE) and scale reliability via Cronbach's alpha (Cr.A) and composite reliability (C.R.) [46,47]. Both reliability scores should exceed the threshold value of 0.6 [44]. Items should achieve minimum factor loadings on their respective scale (factor loadings ≥ 0.4), and scales should extract sufficient variance (AVE ≥ 0.6) from the items to confirm convergent validity [46]. Discriminant validity is evaluated via the heterotrait-monotrait ratio of correlations criterion (HTMT) and the Fornell–Larcker criterion [48,49]. Hair et al. (2022) specifies the Fornell–Larcker criterion is satisfied when the square root of a construct's AVE exceeds any cross-scale correlations and HTMT is satisfied when values

do not exceed the threshold value of 0.9 [46]. Finally, variance inflation factor (VIF) scores exceeding the threshold value of 5 indicate multicollinearity issues, so VIF values should be less than 5 [47].

Following the evaluation of the outer model, the inner model analysis tests the model fit and hypothesized relationships. Hypothesis testing is conducted via bootstrapping with 10,000 iterations [46]. The nonparametric testing procedure focuses on the statistical significance of the estimated path coefficients. Prior to this, model performance indices are checked, including the overall goodness of fit (GoF), normed fit index (NFI), and standardized root mean square residual (SRMR). Larger GoF and NFI values indicate higher performance, and SRMR should be kept low (≤ 0.08 = acceptable, ≥ 0.1 = problematic). Finally, if the explanatory power (R^2) of the model is near 0.25, 0.5, and 0.75, it is considered small, moderate, or large, respectively, and predictive relevance (Q^2) values greater than 0, 0.25, and 0.5 are acceptable, medium, and strong, respectively [46].

4. Results and Discussion

4.1. Sample Description

Table 1 shows the statistical description of the sample, including frequencies, percentages, and percentage information from the most recent US census for comparison. Within the sample, 49% of the respondents were men and 51% were women. The majority of survey subjects were between 25 and 44 years of age and had earned a university qualification. This was a bachelor's degree or an even higher qualification. Approximately 47.3% of the survey respondents came from the South, followed by from the Northeast (21.6%), Midwest (17.7%), and West (13.4%) of the US. Compared with the statistics of most recent US census, the sample could be described as younger, more educated, and less wealthy than US norms.

Table 1. Socio-demographic profile of survey respondents (n = 486).

	Frequency	%	2019 Census%
Age			
18–24	19	3.9	12
25–34	192	39.5	18
35–44	154	31.7	16
45–54	50	10.3	16
55–64	51	10.5	17
65+	20	4.1	21
Total	486	100	100
Education			
Did not finish high school	3	0.6	11
Finished high school	52	10.7	27
Attended university	50	10.3	20
Bachelor's degree	263	54.1	29
Postgraduate degree	118	24.3	13
Total	486	100	100
Annual Pre Tax Household Income			
USD 0 to USD 24,999	74	15.2	18
USD 25,000 to USD 49,999	140	28.8	20
USD 50,000 to USD 74,999	140	28.8	18
USD 75,000 to USD 99,999	92	18.9	13
USD 100,000 or higher	40	8.2	31
Total	486	100	100

Table 1. *Cont.*

	Frequency	%	2019 Census%
Gender Identification			
Men	258	53.1	49
Women	228	46.9	51
Total	486	100	100
Geographical Location			
Northeast	105	21.6	17
South	230	47.3	38
Midwest	86	17.7	21
West	65	13.4	24
Total	486	100	100

4.2. Results of the Measurement Model Analysis

Table 2 displays the reliability and validity parameters, indicating the quality of the measurement model. All values satisfied the criteria specified by Hair et al. (2022) [46]. Construct reliability was confirmed with all reliability requirements met (Cr.A. and C.R. ≥ 0.6), and the convergent validity criteria were met for all scales/items (AVEs ≥ 0.6 and factor loadings ≥ 0.4). Table 3 shows that discriminant validity requirements were fully met using the Fornell–Larker criteria (cross-loadings $< \sqrt{\text{AVEs}}$). Further, the HTMT ratios were all less than 0.90, except between the dependent variables, which measured the same concept but one before and the other since food price inflation. Finally, multicollinearity tests returned an acceptable maximum VIF of 2.118 and average VIF was 1.554 [47].

Table 2. Scale loadings, reliabilities, and convergent validity.

Scales and Items	Factor Loading	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Perceived impact of food price inflation and associated consumer behaviour		0.774	0.868	0.688
Due to food price inflation, my shopping behaviour has changed to include more bulk food.	0.738			
Shortages in food products have led me to competitive and/or panic-buying behaviour.	0.892			
Not having substitute or alternative products makes me anxious	0.852			
Engagement with food-related activities		0.897	0.924	0.709
Reading magazines and books about food production and processing	0.888			
Watching YouTube clips on cooking with plant-based food alternatives	0.886			
Keeping a high stock of food	0.704			
Eating plant-based soul food	0.865			
Buying a cookbook	0.854			
Environmental concerns		0.905	0.940	0.840
Purchasing plant-based milk alternatives saves valuable environmental resources	0.925			
I can help protect the environment by purchasing plant-based milk alternatives	0.897			
I can help decrease environmental problems by purchasing plant-based milk alternatives	0.928			
Accessibility of plant-based substitutes		0.729	0.835	0.630
I have the money to consume alternative plant-based milk alternatives	0.808			
I have opportunities to consume plant-based milk alternatives	0.864			
I have time to consume plant-based milk alternatives	0.701			

Table 2. Cont.

Scales and Items	Factor Loading	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Preferences for plant-based alternatives over regular milk-based products since FPI		0.958	0.969	0.888
Preference for plant-based alternatives or dairy milk	0.962			
Preference for plant-based alternatives or dairy cheese	0.903			
Preference for plant-based alternatives or dairy butter	0.951			
Preference for plant-based alternatives or dairy yoghurt	0.952			
Preferences for plant-based alternatives over regular milk-based products before FPI		0.954	0.966	0.878
Preference for plant-based alternatives or dairy milk	0.958			
Preference for plant-based alternatives or dairy cheese	0.907			
Preference for plant-based alternatives or dairy butter	0.936			
Preference for plant-based alternatives or dairy yoghurt	0.946			

Table 3. Scale discriminant validity.

Fornell–Larcker Criteria	A	B	C	D	E	F
(A) Perceived impact of FPI and associated consumer behaviour	0.830					
(B) Environmental Concerns	0.276	0.917				
(C) Food involvement	0.606	0.465	0.842			
(D) Accessibility of plant-based substitutes	0.22	0.46	0.487	0.794		
(E) Preferences for plant-based over regular milk-based products since FPI	0.528	0.489	0.756	0.478	0.942	
(F) Preferences for plant-based over regular milk-based products before FPI	0.543	0.475	0.759	0.474	0.959	0.937
Heterotrait-Monotrait Ratio	A	B	C	D	E	F
(A) Perceived impact of FPI and associated consumer behaviour						
(B) Environmental Concerns	0.327					
(C) Food involvement	0.723	0.504				
(D) Accessibility of plant-based substitutes	0.240	0.522	0.516			
(E) Preferences for plant-based over regular milk-based products since FPI	0.599	0.524	0.801	0.514		
(F) Preferences for plant-based over regular milk-based products before FPI	0.617	0.511	0.808	0.506	1.004	

4.3. Results of the Structural Model Analysis

The inner model performance indices were calculated and considered acceptable with a GoF of 0.732, NFI of 0.838, and SRMR of 0.067 [46]. In terms of explanatory power, the model's constructs contributed to an R^2 of 0.613 for preference for plant-based alternatives over regular milk-based products since food price inflation and 0.602 for preference for plant-based alternatives over regular milk-based products before food price inflation. These values explained 61.3% of the variance in preferences for plant-based alternatives over regular milk-based products since food price inflation and 60.2% of the variance in preferences for plant-based alternatives over regular milk-based products before the occurrence of food price inflation. This suggests that the model is well suited to explaining preferences for both scenarios. The Stone–Geisser criterion Q^2 evaluated predictive relevance. Adequate predictive relevance was confirmed, with all Q^2 values greater than zero and an average Q^2 score of 0.599, suggesting the model has strong predictive relevance.

4.4. Hypothesis Testing Results

The perceived impact of food price inflation and associated consumer behaviour affected preferences for plant-based alternatives over regular milk-based products since the occurrence of food price inflation, as indicated by a significant relationship, thus supporting hypothesis H1. These findings are in line with recent reports about the US market for plant-based milk products [50]. Even though the market for and product variety of plant-based milk products is still growing, food price inflation has impacted conscious consumer choices. Many consumers still consider plant-based product alternatives to be premium or 'luxury' items and are reserved for occasional purchases [50]. Individuals consuming both regular and plant-based products are particularly budget-conscious [12,50]. Similarly, for both time periods of since and before food price inflation, environmental concerns appear to be a significant predictor, supporting Hypotheses H2 and H3. Food values are the beliefs that affect a consumer's decision making [23]. Not considering these values may lead to dissatisfaction or discontent. Valuing sustainability and climate-consciously produced food items are increasing in their importance among consumers. In particular, the Millennial and Gen-Z generations are concerned about carbon emissions and interested in environmentally friendly food products [23]. Overall, concern for biodiversity and negative externalities influencing climate and the planet are strong consumer drivers of plant-based milk products [12]. Regardless, consumers also make a distinction among alternative milk products. For instance, nut-based products, such as those using Californian almonds, are criticized for their high water footprint [12].

Engagement with food-related activities significantly affects preferences for plant-based alternatives over regular milk-based products since and before the occurrence of food price inflation, as indicated by H4 and H5. These findings are in line with the previous literature. Consumers, in particular those following a vegan or vegetarian diet, usually view their food-related activities as a form of lifestyle [51]. Through food-related activities, consumers build emotional cognitive and behavioural connections in their life worlds [51]. Various US studies indicate a stronger shift from takeaways and restaurant dining towards home gardening, cooking, and food-related activities. This shift can be attributed to tighter budgets resulting from food price inflation [13,22–24].

Lastly, a significant relationship was found between the accessibility of plant-based substitutes and preferences for plant-based alternatives over regular milk-based products since and before the occurrence of food price inflation, supporting Hypotheses H6 and H7 (see Table 4 and Figure 2).

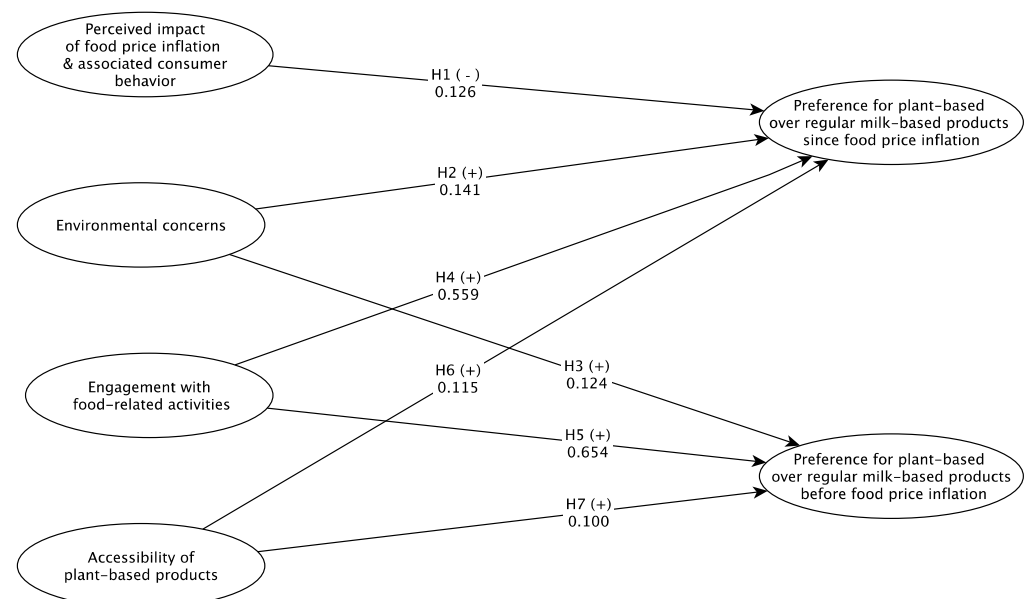


Figure 2. Conceptual model results.

Table 4. Results from Hypothesis testing.

Hypothesised Relationship	Coefficient	T Stat	p-Value
H1: Perceived impact of food price inflation and associated consumer behaviour→Preferences for plant-based alternatives over regular milk-based products since FPI	0.126	2.873	0.004
H2: Environmental concerns→Preferences for plant-based alternatives over regular milk-based products since FPI	0.141	3.973	0.000
H3: Environmental concerns→Preferences for plant-based alternatives over regular milk-based products before FPI	0.124	3.314	0.001
H4: Engagement with food-related activities→Preferences for plant-based alternatives over regular milk-based products since FPI	0.559	12.121	0.000
H5: Engagement with food-related activities→Preferences for plant-based alternatives over regular milk-based products before FPI	0.654	17.746	0.000
H6: Accessibility of plant-based substitutes→Preferences for plant-based alternatives over regular milk-based products since FPI	0.115	3.117	0.002
H7: Accessibility of plant-based substitutes→Preferences for plant-based alternatives over regular milk-based products before FPI	0.100	2.581	0.010

4.5. Suggestions for Marketers in Food Retail

This study focused on predictors determining US consumer preferences for plant-based alternatives over regular milk-based products since and before the occurrence of food price inflation. The conceptual model had satisfactory fit indices, moderate to large explanatory power, and strong predictive relevance. The accessibility of plant-based substitutes, the perceived impact of food price inflation and associated consumer behaviour, engagement with food-related activities, and environmental concerns were important factors both before and since food price inflation. The findings of this study provide insights for marketing managers in US food retail chains. The results regarding consumer attitudes and food-related activities can be used to target different groups of consumers buying plant-based milk products, such as vegan and socially, health-, and climate-conscious consumers. In such cases, it is important to balance the information given to the desired target groups in a marketing campaign. Following Fuentes and Fuentes (2017), it is crucial to deliver marketing messages that appeal also to non-vegan consumers and not to overplay vegan arguments in marketing material and on social media platforms [52]. Sustainability can serve as common interests for all target groups. Product benefits should be approached in a sustainability context and remain transparent, especially regarding sustainable farming practices and impacts on food waste and global warming [52]. Marketers should be mindful of making water-related sustainability claims and attentive toward product pricing. The accessibility of plant-based substitutes may be a factor that could be influential for some consumers, but this is less likely the case for those who are not consuming milk-based products for health reasons or lifestyle choices such as veganism. Food price inflation and the perception of whether or not plant-based milk products are necessary and/or affordable may guide this trend.

4.6. Limitations and Directions for Future Research

The present study builds on data obtained from MTurk, a crowd-sourced research panel platform. This may limit the study in terms of its representativeness. MTurk samples are less representative than samples designed to reflect the US population. Samples from crowdsourcing platforms have, however, been found to be superior to college student samples or samples recruited via social media [45]. To overcome this drawback, future investigations may wish to use opt-in-panel providers and quota sampling. It is envisioned that the most recent US census will serve as an orientation for the quotas to ensure the generalizability of the results.

This research was limited to examining whether consumers have preferences for plant-based substitute products over regular dairy products. Further investigations should compare various dairy products and their plant-based equivalents and consider nutritional

differences and sensory profiles. In addition, the exploration of attribute preferences would be beneficial. Within that, inquiries into consumers' knowledge of dietary functions and the benefits of animal-based vs. plant-based products as well as lifestyle to human health may shed light on reasons behind their purchasing preferences. To achieve such research complexity, a combination of consumer tasting scenarios, eye tracking, and survey work may be suitable for the investigation.

The current work largely emphasizes the environmental sustainability of plant-based milk products. On the grounds of food price inflation, budget consciousness, and the fact that plant-based milk products are closely associated with sustainability, understanding green brand-switching behaviour is appropriate. Future work could build on the work of Wu et al. (2018) [53] and include consumers who drink both plant-based milk alternatives and regular dairy milk and study their brand-switching behaviour. However, caution is needed, and this research should only be conducted when there is a sufficient price gap between plant-based milk alternatives and regular milk. Lastly, an investigation using a grower/production perspectives across countries would be appropriate for future studies as the perspectives of growers and producers are not as widely explored as consumer-based studies. An investigation framed in a sustainability context focusing on understanding limiting factors such as cultivation, irrigation, machinery, and labour and performance indicators would be beneficial for producers striving to achieve sustainable practices and benchmarks.

Other research endeavours could also examine multiple country contexts, enabling a focus on a range of consumption values and cognitive benefits, and insights from these studies could advise global food producers and retailers on how to mitigate switching behaviour.

5. Conclusions

The proposed scales and items were validated, and the conceptual model performed well. Engagement with food-related activities was found to be the largest influencer of preference for plant-based alternatives over regular milk-based products both before and since food price inflation. Environmental concerns and accessibility to plant-based alternatives were also positively associated with a preference for plant-based alternatives. It was hypothesized that customers with a heightened perceived impact of food price inflation would have a lower preference for plant-based substitutes, but the opposite was found.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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