Green Shelves, Greener Choices?

Assessing the Effect of a Supermarket Nudge on Plant-Based Product Sales

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Abstract

This thesis investigates the impact of a behavioural intervention - specifically, a nudge in the form of a “Green Shelf” introduced in a Swedish supermarket - on the sales of plant-based food products. The intervention reorganised plant-based alternatives into a single, visually distinctive shelf to enhance visibility and encourage more sustainable consumer choices. Drawing on behavioural economics and choice architecture theory, the study employs a quasi-experimental design using daily point-of-sale data and applies a Difference-in-Differences (DiD) framework complemented by an event study analysis. Five treated product categories (meatlike, not meatlike, vegetarian fish, tofu/tempeh, vegetarian charcuteries) are compared to a control group (legumes) over an eight-month period.

The findings suggest that while most treatment effects are statistically insignificant, meaningful patterns emerge over time. Notably, the meatlike category - the largest among those examined - shows statistically significant short-term gains following the intervention, highlighting the nudge’s effectiveness in the absence of festive disruptions. Across all categories, sales increase up to the festive season, followed by a noticeable drop persisting through January, and then a gradual rebound beginning in February. These temporal dynamics suggest that although the overall impact appears modest, the intervention may hold the potential for longer-term behavioural change, particularly when external seasonal factors are accounted for. The results also support the parallel trends assumption and illustrate the feasibility of implementing nudging strategies in real-world retail environments. Limitations include the absence of a geographically distinct control store and potential indirect treatment effects on the control group.

This study contributes to the growing literature on nudging and sustainable consumption by providing real-world evidence of a long-duration, low-cost supermarket intervention. Continued monitoring of the Green Shelf, still in place, may offer valuable policy insights into the long-term effectiveness of visibility-based nudges in retail environments.

Keywords: nudging, behavioural economics, sustainable consumption, supermarket intervention, plant-based diets, difference-in-differences.

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Abbreviations

Abbreviation	Description
DiD	Difference in Difference
SUTVA	Stable Unit Treatment Value Assumption
	Swedish University of Agricultural Sciences

1. Introduction

Reducing meat consumption has become a global priority due to its considerable environmental footprint and health-related risks. The livestock sector is a major contributor to greenhouse gas emissions, biodiversity loss, and land and water degradation (Ramankutty et al. 2008). Nearly 40% of the Earth's ice-free land is used for agriculture, with livestock occupying a disproportionate share. From a health perspective, the overconsumption of red and processed meat is linked to elevated risks of cardiovascular diseases, type 2 diabetes, and colorectal cancer (Libera et al. 2021). Allen and Hof (2019) emphasize that continuing current consumption trajectories is incompatible with the Paris Agreement, underscoring the urgent need for sustainable dietary transitions. In response to these challenges, this thesis investigates the effectiveness of a supermarket-based nudging intervention: specifically, whether placing plant-based products on a dedicated green-themed shelf increases their sales in a real-world retail setting.

The central research question is: *Does the green shelf nudge increase the sales of plant-based product categories in a real-world supermarket setting?* To answer this, the study uses point-of-sale data from a Swedish ICA Maxi store and applies a quasi-experimental Difference-in-Differences (DiD) approach complemented by an event study design. These methods aim to capture both short- and medium-term sales dynamics while accounting for seasonal fluctuations and time-specific shocks.

Traditional regulatory tools such as taxes or consumption caps, though potentially effective, often face political and public resistance due to their coercive nature. Behavioural economics offers a promising alternative, focusing on subtle, context-sensitive interventions that account for real-world decision-making constraints. As Just and Gabrielyan (2016) argue, behavioural nudges - small, low-cost adjustments in the choice environment - can leverage predictable consumer biases to promote healthier and more sustainable choices without restricting freedom of choice. Supermarkets, where most food purchasing decisions occur under cognitive load and heuristic shortcuts, are particularly suitable environments for implementing these interventions.

A growing body of empirical literature supports the efficacy of nudging in retail contexts, particularly interventions targeting product visibility and placement (Golding et al. 2022; Hartmann-Boyce et al. 2018; Piernas 2024). Peeters et al. (2024), for instance, show that dedicated "eco-shelves" attract not only environmentally conscious shoppers but also mainstream consumers, boosting engagement with plant-based options. Yet, much of the existing work is limited by short observation periods, small-scale experiments, or simulated environments. Moreover, few studies have examined dynamic treatment effects over time or rigorously tested causal relationships using Difference-in-Differences approaches.

This thesis contributes to the literature in three main ways. First, it offers one of the few real-world evaluations of a long-duration supermarket intervention promoting plant-based choices. Second, it extends the analytical toolkit by combining DiD estimation with an event study design to validate identification assumptions and uncover temporal dynamics. Third, it provides novel evidence on how seasonal patterns - particularly around Christmas - modulate the effectiveness of nudges. Notably, the results show statistically significant short-term sales increases for the "meatlike" category, with a broader post-January rebound across categories, suggesting the potential for sustained behavioural change when festive disruptions subside.

The remainder of the thesis is structured as follows. Chapter 2 outlines the conceptual framework, drawing on behavioural economics and choice architecture to contextualise the intervention. Chapter 3 reviews the relevant empirical literature, highlighting gaps that this study addresses. Chapter 4 describes the intervention, data sources, and econometric methods. Chapter 5 presents the results, including both event study plots and DiD estimates. Chapter 6 discusses the findings in relation to seasonal effects, local consumer demographics, and prior research. Finally, Chapter 7 concludes with policy implications and suggestions for future research.

2. Conceptual Framework

Consumer decision-making is often guided by two cognitive systems: a fast, intuitive one (which we will refer to in the following as "System 1")" and a slower, reflective one ("System 2") (Kahneman, 2011). Most daily choices, including purchasing decisions, are driven by System 1, which relies on heuristics and is highly sensitive to contextual cues. This insight forms the basis of behavioural economics, which recognizes that preferences are not fixed but shaped by the environment in which decisions are made. Thaler and Sunstein (2012) coined the term *choice architecture* to describe how subtle changes in the presentation of options - such as defaults or order effects - can steer behaviour in predictable ways without restricting freedom. A nudge, in this context, is a low-cost intervention embedded within the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives. Nudges work by activating automatic responses, often bypassing deliberative reasoning. From a policy perspective, this makes them a powerful tool to promote healthier, more sustainable choices. Complementing this, Fogg's Behavioural Model (as discussed in Caraban et al. 2019) emphasizes that behaviour emerges when motivation, ability, and a prompt align. Nudging strategies often increase behavioural likelihood by lowering barriers or enhancing the salience of contextual cues. Together, these frameworks offer a robust foundation for understanding how subtle interventions can shape consumer behaviour (Hansen & Jespersen 2013).

In the context of this thesis, these theoretical insights support the design of a nudging intervention aimed at promoting plant-based consumption. Specifically, the nudge consists of a spatial reorganization of a Swedish supermarket: five plant-based product categories - meatlike substitutes, not meatlike substitutes, vegetarian fish, tofu/tempeh, and vegetarian charcuteries - were relocated from dispersed locations to a single, green-themed "eco-shelf". This visually distinctive arrangement was intended to enhance product visibility and prompt more sustainable choices by activating heuristic-driven System 1 responses.

Based on this conceptual framework, the hypothesis is twofold. First, it is expected that the nudge will lead to an increase in sales for at least some of the treated plant-based categories, particularly those that are more familiar or meat-resembling. Second, given the dominance of culturally traditional foods during the festive season (many of which are meat or fish based) a temporary decline in sales of plant-based alternatives is anticipated around Christmas, followed potentially by a rebound in the post-holiday period.

3. Literature Review

This chapter reviews the existing theoretical and empirical literature on nudging strategies in food retail environments. Section 3.1 synthesizes insights from recent meta-analyses and reviews, outlining general patterns of effectiveness and theoretical mechanisms underlying behavioural nudges, particularly in supermarket settings. Section 3.2 presents a structured analysis of 18 empirical studies, categorized by intervention context, behavioural goal, type of choice architecture, and evaluation method. Together, these sections establish the conceptual and methodological foundation for this thesis and help position its contribution (section 3.3) within the existing literature.

3.1 Evidence from Systematic Reviews and Meta-Analyses

Recent systematic and meta-analytical reviews support the effectiveness of nudging in food retail environments, particularly when interventions are aligned with automatic, System 1 processes (Hummel & Maedche 2019; Bianchi et al. 2018). Nudges that restructure the physical micro-environment, such as altering the visibility, position, or accessibility of items, have been shown to influence purchasing decisions even when intentions remain unchanged (Bianchi et al., 2018; Bucher et al. 2016). These effects are especially relevant for habitual behaviours like meat consumption, which are largely context-driven rather than consciously regulated. Within this domain, evidence suggests that convenience-enhancing nudges outperform purely cognitive or affective strategies by making desirable behaviours easier to perform, thereby bypassing both rational resistance and emotional inertia (Cadario & Chandon 2020). Nonetheless, visibility-based nudges, such as changes in shelf arrangement, remain effective and are often more feasible to implement in complex retail settings (Cadario & Chandon, 2020; Bucher et al., 2016). These findings are echoed in reviews specifically focused on supermarkets, which highlight the promise of interventions targeting layout, availability, and in-store prompts to shift purchasing behaviour toward healthier choices (Golding et al., 2022; Hartmann-Boyce et al., 2018). Collectively, the literature affirms the strategic value of nudging in shaping consumer decisions through minimal yet targeted environmental changes.

3.2 Review of Empirical Studies

To structure the review of empirical studies, we selected 18 peer-reviewed interventions focused on influencing food choices through nudging. These studies were systematically categorized based on four key dimensions. First, the food-related behavioural goal was classified into two groups: meat substitution or reduction, and other goals such as promoting healthier snack choices, increasing fruit and vegetable intake, or encouraging more sustainable consumption behaviours. Second, the intervention setting was distinguished between supermarket or retail environments (including both real and simulated shopping contexts) and other environments such as cafeterias or restaurants. Third, the type of choice architecture was categorized as either labelling interventions (e.g., informational or evaluative labels) or positional/proximity nudges (e.g., shelf placement or product ordering). Lastly, the analytical method used to assess impact was divided between studies that employed a difference-in-differences (DiD) framework, as used in the present thesis, and those using alternative statistical or experimental approaches. The classification also considered reported outcomes, distinguishing between positive, null, negative, or mixed effects based on statistical significance and direction of change. While Table 1 offers a comparative overview across key dimensions, a more detailed summary of each intervention study, including setting, design, sample size, method, and main findings, is provided in Appendix 1.

Next, the different categories of the literature are presented and discussed in detail, followed by a subsection outlining how this thesis contributes to these existing strands of research.

3.2.1 Intervention Settings

The supermarket and broader retail environment have emerged as highly effective settings for nudging interventions aimed at encouraging healthier and more sustainable food choices. Of the 14 studies reviewed in this category, 8 were conducted in real-world supermarkets, reflecting the relevance of these spaces for influencing habitual consumer behaviour. Due to their fast-paced nature and high stimulus load, supermarkets often elicit automatic, heuristic-based decisions (System 1), making them ideal for interventions that subtly modify the decision environment. Rather than relying on conscious deliberation, such nudges influence what consumers notice, consider, and ultimately choose. For instance, Van der Meer et al. (2025) and Vandenbroele et al. (2021) show that repositioning plant-based products within the meat aisle not only increased their visibility but also shifted how consumers mentally classified them, bridging categorical boundaries and encouraging trial among regular meat shoppers. In another example, Gillebaart et al. (2023) tested an interactive “affordance nudge” and found that it significantly increased vegetable purchases, further confirming the effectiveness of in-store cues in shaping real-world food decisions.

Other studies reinforce these findings by targeting specific areas of the supermarket. For example, Coucke et al. (2019) manipulated the size and prominence of display areas in a supermarket butchery, resulting in increased sales of more sustainable poultry products. Checkout areas have also been used as behavioural leverage points: both Adjoian et al. (2017) and Winkler et al. (2016) implemented “healthy checkout” designs by replacing confectionery with fruit or healthier snacks, with mixed but promising results in increasing healthy purchases. Interventions based on labelling and information provision have likewise been trialled. Elofsson et al. (2016) conducted a randomized field experiment in Swedish retail stores, finding that voluntary carbon labels increased sales of climate-certified milk, particularly in larger stores. Likewise, Vandevijvere et al. (2021) implemented electronic shelf labels (ESLs) featuring Nutri-Score in a chain of Belgian supermarkets, reporting modest but statistically significant shifts in purchases toward products with healthier nutritional profiles, though impacts varied across food categories.

These real-world results are complemented by four studies conducted in simulated retail environments (e.g., online choice experiments), which allow for greater experimental control while still capturing relevant choice dynamics. For instance, Peeters et al. (2022) and Grandi et al. (2021) explored the effect of redesigned shelf layouts and simplified nutritional labels in virtual shopping tasks, both reporting positive behavioural shifts. Taillie et al. (2021) and Ragheobar et al. (2020) tested exposure to environmental warnings or increased availability of plant-based items, respectively, with mixed effects on actual or perceived consumption norms. Although less ecologically valid than field experiments, these simulation studies contribute important insights into mechanisms of behavioural change and consumer interpretation of nudges.

Outside supermarkets, a smaller subset of studies explored nudges in non-retail food environments, such as a train station snack shop (Kroese et al., 2016) and a hospital food vendor (Cheung et al., 2019). While these settings showed some promise - particularly in enhancing accessibility or salience of healthier items - their limited scale and context-specific constraints reduce their generalizability. In contrast, supermarkets offer a robust and scalable platform for nudge implementation, reaching diverse consumer groups and integrating seamlessly into existing shopping habits.

3.2.2 Food-Related Behavioural Goals

A substantial portion of the reviewed literature focuses specifically on reducing meat consumption or promoting the uptake of meat substitutes, highlighting growing research interest in behavioural nudges as a tool for dietary and environmental change. These interventions, implemented across both simulated and real-world settings, predominantly apply choice architecture modifications to influence consumer behaviour at the point of purchase or selection. Overall, the evidence suggests that nudging can effectively support meat substitution, with most studies reporting positive or mixed effects. For example, Vandenbroele et al. (2021)

and Van Der Meer et al. (2025) demonstrate that repositioning meat substitutes within the meat section of retail environments can increase their sales, particularly among meat-eaters and flexitarians. However, such interventions do not consistently lead to reductions in meat purchases, indicating that substitution may be partial or context dependent. Kurz (2018) and Coucke et al. (2019) similarly find that visibility enhancements and spatial rearrangements can shift consumer choices toward vegetarian or lower-impact meat options such as poultry. Labelling interventions also play a role, with Lohmann et al. (2022) and Taillie et al. (2021) showing that carbon footprint and health/environment warning labels can affect perceptions and, to a lesser extent, behaviour. Nevertheless, results vary by message framing and behavioural context, with Vasiljevic et al. (2024) and Peeters et al. (2022) emphasizing that the salience and perceived relevance of the nudge are critical factors. Other studies such as Ragheobar et al. (2020) explore changes in perceived social norms, while Hughes et al. (2023) highlight the potential of pictorial warnings to reduce hypothetical meat selection.

In sum, while nudging strategies targeting meat consumption show promising results, especially in encouraging the uptake of plant-based alternatives, their effectiveness often depends on the interplay between visibility, availability, framing, and consumer motivation.

3.2.3 Type of Choice Architecture

The reviewed interventions primarily apply two types of nudges: labelling and positioning or proximity changes, with some studies combining both. Labelling interventions aim to influence decision-making by providing simplified, often value-laden information at the point of choice. Lohmann et al. (2022) and Elofsson et al. (2016) show that carbon footprint labels and sustainability signs can modestly shift purchases toward lower-impact products, though effects tend to be short-term or context-dependent. Warning labels, particularly when health-framed or pictorial, have shown greater potential to shape consumer evaluations. Hughes et al. (2023) report significant reductions in meat selection across various label types, while Taillie et al. (2021) and Vasiljevic et al. (2024) find that labels can influence perceptions and intentions, even if behavioural outcomes remain mixed.

By contrast, positioning and proximity nudges demonstrate more robust and consistent effects in influencing actual behaviour. These interventions alter the physical placement or visibility of products to guide choices automatically, bypassing the need for cognitive effort. Across retail and food-service contexts, this approach has repeatedly proven effective. For example, Van der Meer et al. (2025) and Vandenbroele et al. (2021) repositioned meat substitutes within the meat aisle to increase salience and recategorize them in consumers' mental frameworks. Their results show increased sales of meat substitutes, especially among flexitarians, though the interventions did not lead to significant reductions in meat purchases. In contrast, Grandi et al. (2021) adopted a more integrated approach by combining shelf layout changes with simplified nutritional cues in a simulated retail environment. Their findings confirm that spatial arrangement and ease of navigation are key drivers of healthier food selection, particularly when cognitive overload is minimized.

Additional spatial nudges across real-world contexts further reinforce this pattern. Coucke et al. (2019) and Kurz (2018) show that changes in shelf space, menu order, or display prominence can meaningfully shift preferences toward more sustainable or vegetarian options. Similarly, interventions in checkout and snack areas (Adjoian et al. 2017, Winkler et al. 2016, and Kroese et al. 2016) highlight that even subtle adjustments to product placement can prompt healthier purchasing. These findings suggest that spatial nudges, particularly those leveraging visibility and accessibility, are highly scalable and behaviourally powerful strategies for shifting consumer behaviour.

Some studies combined labelling with spatial interventions. Cheung et al. (2019) found that repositioning fruit was more effective than salience or social proof nudges. Grandi et al. (2021) similarly showed that combining layout changes with simplified labels can support healthier choices, depending on product type and context. These results underline the added value of positioning-based strategies, even when used alongside informational cues.

3.3 Key Contributions of This Thesis

Despite the promising results across the 18 reviewed interventions, only two studies - Van der Meer et al. (2025) and Vandenbroele et al. (2021) - combine four key features central to this thesis: a real supermarket setting, the use of positioning nudges, a primary focus on increasing meat substitute sales, and the application of Difference-in-Differences (DiD) as an analytical strategy. Their findings confirm that repositioning nudges in supermarket settings are effective in increasing the visibility and uptake of plant-based alternatives, highlighting how changes in spatial arrangement can meaningfully influence consumer behaviour. However, few studies to date have used DiD methods, which are particularly well-suited to evaluate causal effects in non-randomized, real-world interventions. Studies such as Kurz (2018), Lohmann et al. (2022), and Elofsson et al. (2016) illustrate the value of DiD in isolating treatment effects over time across comparison groups, even in complex retail environments. Moreover, very few interventions lasted beyond ten weeks, Van der Meer et al. (2025) and Kurz (2018) being the exceptions, limiting insights into longer-term behavioural shifts.

The main contribution of this thesis lies in providing a timely and real-world evaluation of a sustained spatial intervention: a “Green Shelf” implemented in a real supermarket to promote plant-based alternatives. The primary objective is to assess whether the intervention increased the sales of plant-based categories displayed on the dedicated shelf. The analysis is conducted using a Difference-in-Differences (DiD) approach, enabling a robust estimation of the nudge's causal impact by comparing pre- and post-intervention trends across treated and control product groups. Notably, the nudge remains in place at the time of writing, and the available dataset spans 21 weeks post-intervention, allowing for a policy-relevant evaluation of its medium-term effects.

Table 1 Summary of Reviewed Literature on Nudge Interventions to Influence Food Choice

Author(s) Year Country	**Setting/Environment**		**Food-Related Goal**		**Choice Architecture**		**Analytical Method**		**Effect**[1]
	Supermarket or Retail Environment	Cafeteria or Restaurant	Meat Substitution/ Reduction/ Transition	Others	Label	Positioning/ Proximity	DiD	Others	Positive / Null / Negative / Mixed
(Adjoian et al. 2017) USA	✓	✗	✗	✓	✗	✓	✗	✓	Positive
(Cheung et al. 2019) Netherlands	✗	✓	✗	✓	✓	✓	✗	✓	Mixed
(Coucke et al. 2019) Belgium	✓	✗	✓	✗	✗	✓	✗	✓	Positive
(Elofsson et al. 2016) Sweden	✓	✗	✗	✓	✓	✗	✓	✓	Positive

[1] "Effect" classification is based on the direction and statistical significance of the main outcome measure reported by each study. "Positive" refers to a significant increase in desired behaviours (e.g., healthier or more sustainable food choices), "Null" to no significant effect, "Negative" to a significant reduction, and "Mixed" to varied or conditional results.

Author(s) Year Country	Setting/Environment		Food-Related Goal		Choice Architecture		Analytical Method		Effect[1]
	Supermarket or Retail Environment	Cafeteria or Restaurant	Meat Substitution/ Reduction/ Transition	Others	Label	Positioning/ Proximity	DiD	Others	Positive / Null / Negative / Mixed
(Gillebaart et al. 2023) Netherlands	✓	✗	✗	✓	✗	✓	✗	✓	Positive
(Grandi et al. 2021) UK	✓	✗	✗	✓	✓	✓	✗	✓	Mixed
(Hughes et al. 2023) UK	✗	✓	✓	✗	✓	✗	✗	✓	Positive
(Kroese et al. 2016) Netherlands	✓	✗	✗	✓	✗	✓	✗	✓	Positive
(Kurz 2018) Sweden	✗	✓	✓	✗	✗	✓	✓	✓	Positive
(Lohmann et al. 2022) UK	✗	✓	✓	✗	✓	✗	✓	✓	Positive

Author(s) Year Country	Setting/Environment		Food-Related Goal		Choice Architecture		Analytical Method		Effect[1]
	Supermarket or Retail Environment	Cafeteria or Restaurant	Meat Substitution/ Reduction/ Transition	Others	Label	Positioning/ Proximity	DiD	Others	Positive / Null / Negative / Mixed
(Peeters et al. 2022) Netherlands	✓	✗	✓	✗	✓	✗	✗	✓	Mixed
(Raghoebar et al. 2020) Netherlands(Taillie et al. 2021)	✓	✗	✓	✗	✗	✓	✗	✓	Mixed
(Taillie et al. 2021) USA	✓	✗	✓	✗	✓	✗	✗	✓	Null
(Vandenbroele et al. 2021) Belgium	✓	✗	✓	✗	✗	✓	✓	✓	Positive

Author(s) Year Country	Setting/Environment		Food-Related Goal		Choice Architecture		Analytical Method		Effect[1]
	Supermarket or Retail Environment	Cafeteria or Restaurant	Meat Substitution/ Reduction/ Transition	Others	Label	Positioning/ Proximity	DiD	Others	Positive / Null / Negative / Mixed
(Van Der Meer et al. 2025) Netherlands	✓	✗	✓	✗	✗	✓	✓	✓	Mixed
(Vandevijvere & Berger 2021) Belgium	✓	✗	✓	✓	✓	✗	✓	✓	Mixed
(Vasiljevic et al. 2024) UK	✗	✓	✓	✗	✓	✗	✗	✓	Null
(Winkler et al. 2016) Denmark	✓	✗	✗	✓	✗	✓	✗	✓	Mixed

4. Methods and Data

This section outlines the design, implementation, and analytical approach of the study. It begins by describing the supermarket intervention and the structure of the dataset, followed by the empirical strategy used to estimate the treatment effect. Finally, it discusses the identification assumptions underlying the Difference-in-Differences (DiD) framework and the role of the event study in validating these assumptions.

4.1 Intervention

The intervention consists of a spatial reorganisation of the supermarket layout through the creation of a dedicated "Green Shelf" aimed at increasing the visibility and accessibility of plant-based alternatives. Specifically, five product categories - meat-like substitutes, non-meat-like substitutes, tofu/tempeh, vegetarian charcuteries, and vegetarian fish - were relocated from various dispersed locations within the store to a single, prominently placed shelf designed to attract consumer attention. This unified shelf replaced the traditional categorisation by product type with a goal-derived organisation based on dietary preference, highlighting plant-based options as a clear and separate choice for consumers. The intervention was implemented in a Maxi ICA supermarket located in Nacka, in the southern area of Stockholm[2], as a real-world behavioural experiment. Importantly, the change in shelf organisation was not explicitly communicated to customers, and the overall assortment of products remained unchanged. The restructuring process began in early October 2020, and the intervention formally started on 4 November 2020. Sales data at the point of sale (POS) were collected from 1 August 2020 to 31 March 2021, allowing for both pre- and post-intervention analysis. As the Green Shelf remains in place at writing time, the available data enable an evaluation of short- to medium-term behavioural effects, with potential for longer-term insights for future research.

[2] Maxi ICA Stormarknad Nacka, Stockholm. Store information available at: https://www.ica.se/butiker/maxi/nacka/maxi-ica-stormarknad-nacka-1004282

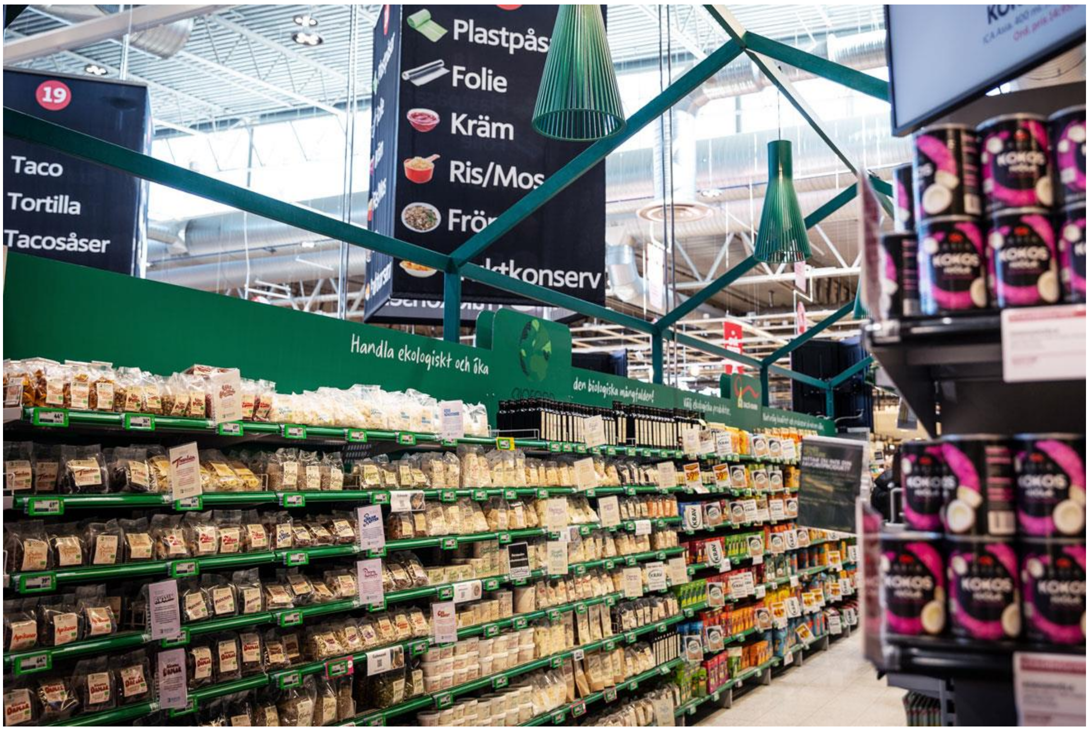

Figure 1 Green shelf layout at ICA Maxi Nacka. Source: INTRX, 2023, https://intrx.se/ica-maxi-nacka-2/

Figure 2 Green shelf layout at ICA Maxi Nacka. Source: INTRX, 2023, https://intrx.se/ica-maxi-nacka-2/

4.2 Data

The dataset used in this study was provided as part of the EPIC project (Economic Policy Instruments for reducing Climate Impact from food in Sweden), a research initiative financed by Formas.

The dataset is Point-of-sale (POS) data, covering the period from 1 August 2020 to 31 March 2021, resulting in 243 daily observations. For each day, the dataset includes the total quantity sold (in kilograms) and the total value (in SEK) for every good. Although price information is available, the present analysis uses only daily quantity data, calculated by summing the kilograms sold across all included product variants (e.g., different tofu brands) on that date.

Products were structured into categories and subcategories according to a predefined classification system provided with the dataset. This categorisation was not carried out by the author. Of primary interest are the five plant-based product categories: meat-like substitutes, non-meat-like substitutes, tofu/tempeh, vegetarian charcuteries, and vegetarian fish. Additional data were provided for potential control groups: Legumes, Meat (aggregated from subcategories such as beef, pork, poultry, minced meat, offal, processed meats, and deli-counter items), and Fruits & Vegetables (aggregated from fruits, berries, roots, and leafy greens). These additional data are tested during the preparatory analysis phase to determine the most suitable comparison group. Legumes are ultimately selected as the control group, as they provide the best pre-intervention trends (see subsection 5.1 for details) for the research objectives. However, all three groups were considered to assess the robustness and contextual relevance of the DiD framework.

4.2.1 Descriptive Statistics

The descriptive statistics reported in Table 2 and Table 3 illustrate the evolution of daily sales quantities across product categories before and after the nudge intervention. Table 2 captures the full post-intervention period, while Table 3 focuses on a restricted window ending on December 15, thereby excluding the holiday season. Across both tables, we observe an increase in mean daily sales for all treated plant-based categories after the intervention. Notably, when limiting the analysis to the shorter post-nudge period in Table 3, the control group (pure legumes) shows only a marginal increase in sales, from 200.8 kg to 202.5 kg per day, a difference of just 1.8 kg. This contrasts with the full-period comparison in Table 2, where legumes increase by 15.6 kg. More importantly, the growth in the control group remains modest relative to the treated categories: in Table 3, meatlike and not meatlike products grow by 21.4 kg and 7.7 kg per day respectively, clearly outpacing legumes. These differences indicate that, during the initial post-intervention phase, the control group remains relatively stable while treated categories experience more pronounced changes. The relative stability of the control group during the restricted post-intervention period is consistent with the expectations of the DiD framework and strengthens its use as a baseline for comparison in the subsequent analysis.

Table 2 Average daily sales by category before (Aug 1–Nov 3) and after (Nov 4–Mar 31, 2021) the nudge

Category	Mean Before (SD)	Mean After (SD)	Change
Pure Legumes	**200.8 (49.7)**	**216.4 (55)**	**15,6**
Meatlike	67.3 (16.9)	90.8 (23.9)	23,7
Not Meatlike	9.9 (4.2)	15.5 (5.5)	5,6
Tofu Tempeh	8.2 (3)	10.1 (4.1)	1,9
Vegetarian Charcuteries	2.2 (0.8)	2.8 (1)	0,6
Vegetarian Fish	1 (0.7)	1 (0.8)	0,1

Table 3 Average daily sales by category before (Aug 1–Nov 3) and after (Nov 4–Dec 15, 2020) the nudge

Category	Mean Before (SD)	Mean After (SD)	Change
Pure Legumes	**200.8 (49.9)**	**202.5 (43.3)**	**1,8**
Meatlike	67.3 (16.9)	88.7 (20.6)	21,4
Not Meatlike	9.9 (4.2)	17.5 (5.6)	7,7
Tofu Tempeh	8.2 (3)	9.1 (3.5)	0,9
Vegetarian Charcuteries	2.2 (0.8)	2.9 (0.9)	0,8
Vegetarian Fish	1 (0.7)	0.9 (0.5)	-0,1

4.3 Analysis

To estimate the impact of the intervention on the quantity of plant-based products sold, we apply a DiD approach. This quasi-experimental method allows us to isolate the causal effect of the nudge by comparing changes in outcomes over time between a treated group and a control group. The DiD design controls for unobserved time-invariant heterogeneity and for time-varying shocks that are common to both groups (Wing et al. 2018). In our case, the treated group includes five plant-based product categories affected by the intervention, while the control group consists of the legume category, which remains outside the green shelf and thus unaffected by the nudge.

We estimate the following model:

$$\text{Daily\_Quantity}_{it} = \alpha + \beta_1 Treatment_i + \delta(Treatment_i \times Post_t) + \gamma_t + \theta_d + \varepsilon_{it}$$

Here, the dependent variable $\text{Daily\_Quantity}_{it}$ represents the number of kilograms sold of product i on day t. Treatment_i is a binary indicator equal to 1 for treated categories, estimated separately, and 0 for the control category. The interaction term $\text{Treatment}_i \times \text{Post}_t$ captures the DiD estimator δ, which identifies the treatment effect. We include daily fixed effects (γ_t) to account for time-specific shocks and day-of-the-week fixed effects (θ_d) to control for systematic variations in sales across weekdays. The model is estimated using the Fixed Effects Ordinary Least Squares (`feols()`), that clusters standard errors at the level of fixed effects. This helps address concerns about serial correlation in panel data, a well-documented issue in DiD estimation (Bertrand et al. 2004).

To account for potential confounding from holiday-related consumption patterns, we repeat the estimation using the model discussed above for a restricted post-treatment period that excludes the Christmas season.

This modelling strategy allows us to estimate effects for the full time period, and for a more controlled timeframe unaffected by seasonal consumption spikes. In both models, we rely on the same fixed effects structure and clustering method to ensure robust inference (Wing et al. 2018).

4.3.1 Assumptions of the Model and Event Study

In order to identify a causal effect through a DiD framework, two main assumptions should hold: the *Parallel Trends Assumption* and the *Stable Unit Treatment Value Assumption* (SUTVA). Both are critical for ensuring the internal validity of the estimated treatment effects, but they differ in their applicability and testability within our study.

The Parallel Trends Assumption is the cornerstone of the DiD design. It requires that in the absence of the intervention, the treated and control groups would have followed the same trend in the outcome variable over time. This assumption enables us to attribute any deviation in trends after the intervention to the treatment itself, rather than to underlying differences between groups. In our context, this implies that, had the nudge not been introduced, the quantities sold of the treated plant-based categories and the control group would have evolved similarly over time. This assumption corresponds to the requirement that time-varying unobserved confounders affect both groups in the same way, a point emphasized in the literature as the common trends assumption (Wing et al. 2018).

While we cannot directly test this assumption, we can inspect its plausibility by analysing pre-treatment trends. For this purpose, we conduct an event study prior to estimating the DiD model. This aligns with best practices in the DiD literature, where testing for parallel trends through visual and statistical analysis of pre-intervention dynamics is a recommended robustness check (Bertrand et al., 2004; Wing et al., 2018).

To formally assess the presence of parallel trends, we estimate the following event study specification:

$$\text{Daily\_Quantity}_{it} = \alpha + \beta_1 Treatment_i + \sum_{k \neq -6} \delta_k \, (Week\_Event_k) Treatment_i + \gamma_t + \theta_d + \varepsilon_{it}$$

In this model, we interact the treatment indicator with a set of time dummies capturing weekly deviations from a reference period. These variables, indicated as Week_Event_k in the equation above, take value one for the treated group at time period *k*, and zero otherwise. The reference week, which is six weeks before the nudge started, falls at the end of September 2020, preceding the beginning of shelf construction. The separate green shelf was under construction throughout October, and the nudge was officially implemented on November 4, 2020. By using this reference week -6 as baseline, we ensure that the comparison is anchored before any visible changes in the store layout or consumer experience began. This model also allows us to evaluate dynamic treatment effects, as it captures how the outcome variable evolves in both the pre-treatment and post-treatment periods relative to the reference week.

The `feols()` function automatically clusters standard errors at the level of the fixed effects (in this case, Date and Day_of_Week), which addresses concerns about underestimated standard errors due to serial correlation, which is a common issue in DiD settings highlighted by (Bertrand et al. 2004). Although the estimation is based on daily sales data, the results are plotted using weekly event time, allowing us to observe the estimated effect of the treatment relative to the pre-intervention baseline.

The event study plots visualize the estimated treatment coefficients for each week, along with 95% confidence intervals. The expected pattern is that coefficients for pre-intervention weeks are statistically insignificant and centred around zero, which would support the validity of the parallel trends assumption. Conversely, coefficients for post-treatment weeks are expected to be significantly different from zero, indicating the presence of a treatment effect.

The second identifying assumption, the Stable Unit Treatment Value Assumption (SUTVA), requires that the treatment status of one unit does not affect the outcome of another unit and that there is no hidden variation in treatment. In classical DiD designs, SUTVA is most credibly validated when using a separate control group, such as another supermarket or store that is unaffected by the treatment. However, in our case, we rely on internal control products within the same supermarket (legumes), which limits our ability to fully satisfy this assumption. This is because the treatment could theoretically affect the control group too: the introduction of the green shelf might influence the consumers' propensity to shop for legumes, even though they are not present on the shelf. Therefore, we acknowledge that SUTVA may not fully hold, and this represents a limitation of our study design. This concern is not uncommon in quasi-experimental setups where perfect isolation of units is difficult (Wing et al., 2018). As such, our results should be interpreted as relative effects between product categories rather than clean causal estimates based on spatially distinct units.

Despite this limitation, the use of an internal control group is a pragmatic solution given the constraints of the available data. We mitigate potential biases by excluding the Christmas period in a secondary model and by thoroughly inspecting pre-trend dynamics through the event study. These steps strengthen the credibility of our identification strategy and offer additional transparency around the underlying assumptions.

5. Results

This section presents the empirical findings from the analysis of the nudge intervention aimed at increasing sales of plant-based products. The event study illustrates the temporal dynamics of treatment effects around the intervention date, providing a visual representation of weekly patterns in product sales. The DiD analysis quantifies the average treatment effects across five plant-based product categories, comparing them to a control group over two different time periods. Together, these methods offer a robust understanding of the short- and medium-term responses to the behavioural nudge.

5.1 Event Study

The event study plots below display the estimated weekly treatment effects on daily quantities sold (measured in kilograms per day) for five plant-based product categories following the implementation of the nudge. The estimations are derived from fixed effects regressions described in 4.3.1 that account for both day-of-week and date-specific variations. Although the estimates are based on daily transaction data, the coefficients are aggregated at the weekly event level for interpretability. The x-axis represents event time in weeks relative to the nudge, while the y-axis displays the estimated treatment effect in kilograms per day.

Each plot features three distinct shaded regions to contextualize the event timeline. The red area, spanning from week -13 to week -6, corresponds to the pre-nudge period leading up to the baseline reference week (week -6). The unshaded white area from week -6 to week 0 captures the intermediate period between the baseline and the start of the nudge. The blue-shaded region, beginning at week 0, denotes the post-nudge period, with week 0 corresponding to the implementation of the nudge during the week of November 4th.

Across all five categories (meatlike, not meatlike, vegetarian fish, tofu/tempeh, and vegetarian charcuteries) the parallel trends assumption appears to hold. Most pre-intervention coefficients are statistically insignificant, with standard errors crossing the zero line, indicating no significant differences in trends between treated and control groups before the nudge was introduced. This supports the validity of the DiD framework. Following the implementation of the nudge, a broadly consistent pattern emerges across categories: coefficients tend to rise, suggesting an increase in daily sales of plant-based alternatives. However, only a few of these post-treatment coefficients, particularly those around the Christmas period, reach statistical significance. A distinct decline is visible around weeks 7 to 9, coinciding with the festive season, and this dip persists throughout January. From approximately week 12 onward, a renewed upward trend in daily sales appears, indicating a recovery beginning in February. This shared temporal pattern provides a visual representation of the dynamic effects of the nudge intervention across the selected categories.

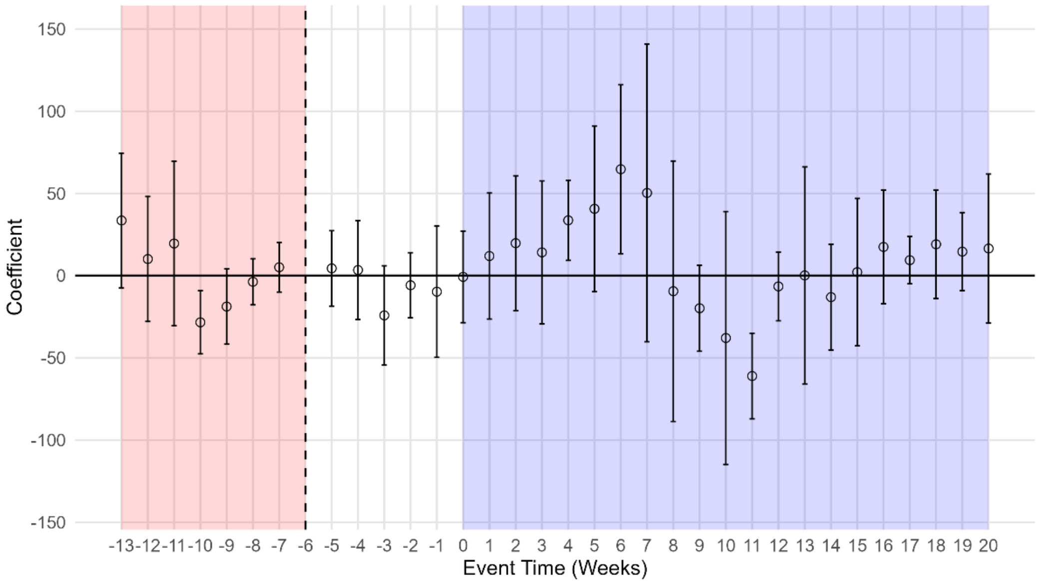

Figure 3 Event Study Plot: Meatlike

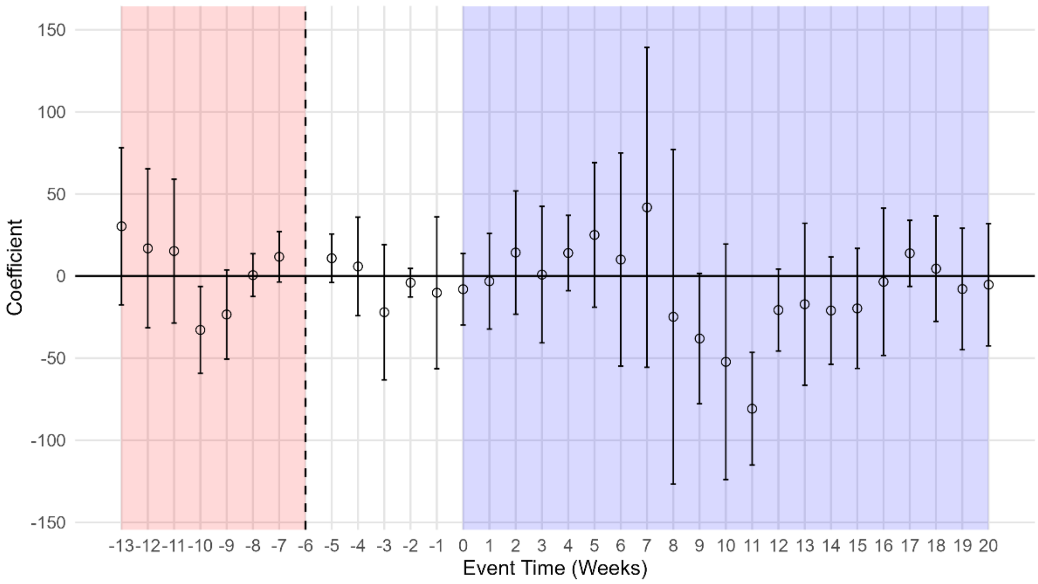

Figure 4 Event Study Plot: Not Meatlike

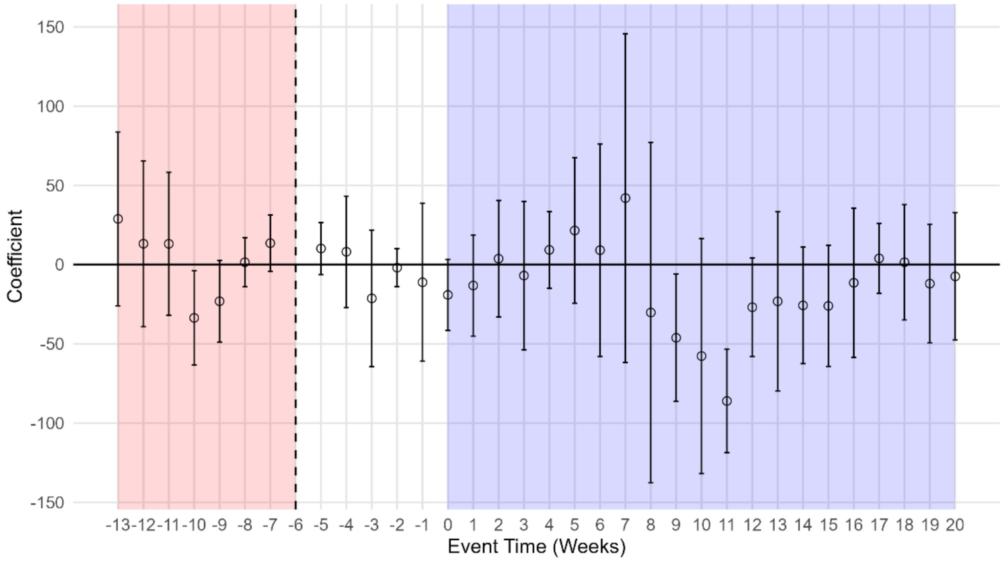

Figure 5 Event Study Plot: Vegetarian Fish

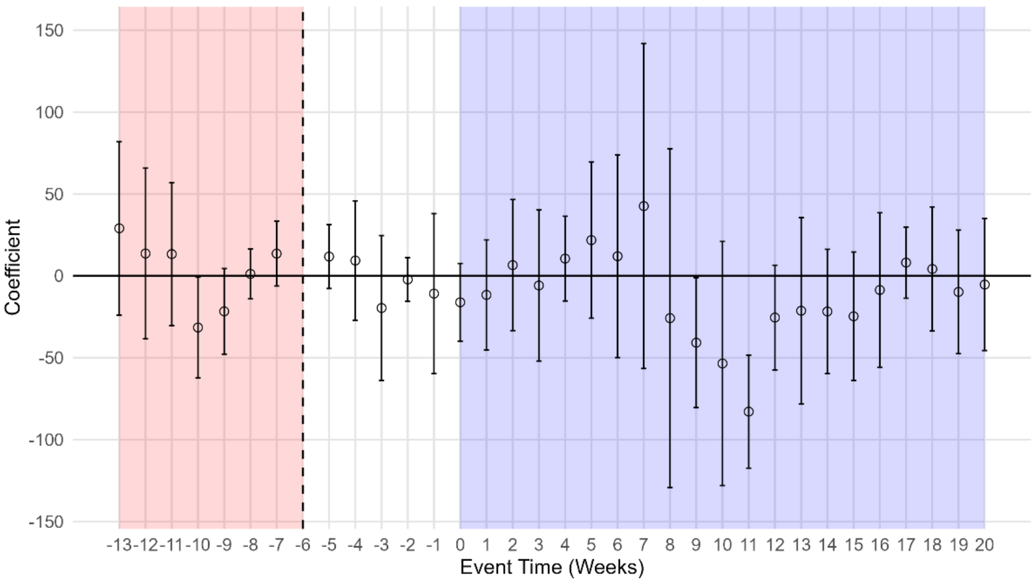

Figure 6 Event Study Plot: Tofu/Tempeh

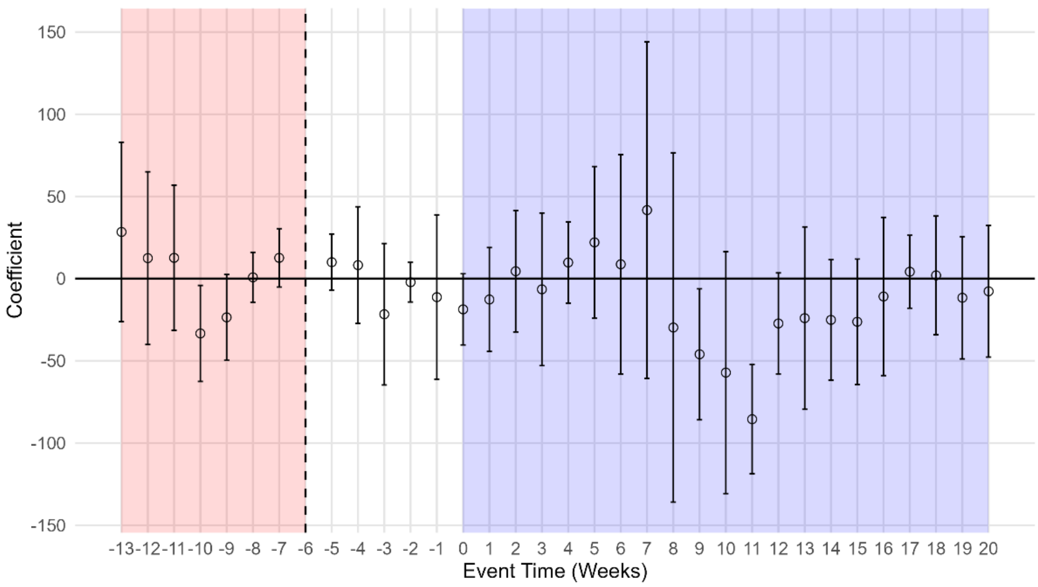

Figure 7 Event Study Plot: Vegetarian Charcuteries

5.2 DiD Estimation

This subsection summarizes the structure and scope of the DiD estimation results derived from the model described in 4.3.

Tables 4 through 8 present the DiD estimates for each of the five treated plant-based product categories compared against the control group. Each table contains four model specifications. Columns (1) and (2) report estimates using the full time span from August 1, 2020, to March 31, 2021, while columns (3) and (4) present estimates restricted to the pre-festive period, from August 1, 2020, to December 15, 2020. For both timeframes, the models are run with different combinations of fixed effects: column (1) includes daily fixed effects only, column (2) includes both daily and day of the week fixed effect. The same structure applies to the restricted-period models in columns (3) and (4).

The DiD coefficient ($Treatment_i \times Post_t$) indicates the estimated change in average daily quantity sold in the treated category, relative to the control group, after the nudge intervention. Standard errors are reported in parentheses beneath each coefficient. Statistical significance is denoted by asterisks, where ***$p < 0.01$, **$p < 0.05$, and *$p < 0.1$. The average value of the dependent variable (Avg. DV) is reported for each category and time span, calculated over the entire period used in the estimation (either full or restricted). This provides a reference for interpreting the size of the DiD estimates relative to typical quantities sold.

Across all specifications within a given time span, the DiD point estimates remain very similar or identical, though standard errors vary slightly depending on the fixed effects included. This consistency suggests that the estimated treatment effects are robust to different time fixed effects. For example, in Table 4 (Meatlike), the the DiD estimates maintain the same values (7.76735 and 19.6951) for all full-period (columns 1–2) and restricted-period models (columns 3–4), although the significance level improves when daily and weekday fixed effects are included. This pattern is consistent across the other tables.

Among all product categories, Meatlike stands out with a notably higher average value of the dependent variable (81.45 in the full period and 73.83 in the restricted period), and it is the only category showing positive and statistically significant DiD estimates. Specifically, columns (3) and (4) of Table 4 show a DiD estimate of 19.6951 significant at the $p < 0.05$ level, which corresponds to approximately a 27% increase relative to the restricted period average. Not Meatlike shows a positive DiD estimate in the restricted period (5.9131 in columns 3–4 of Table 5), while in the full period the effect is negative and non-significant (-9.87349 across columns 1–2).

The remaining three categories - Vegetarian Fish, Tofu/Tempeh, and Vegetarian Charcuteries - show consistently negative DiD estimates, most of which are not statistically significant. An exception appears in Table 6 (Vegetarian Fish), where the estimate in column (1) is significant at the $p < 0.1$ level. Table 7 (Tofu/Tempeh) shows one significant DiD estimate in column (1) at the $p < 0.1$ level. Additionally, across all categories, the DiD estimates in the restricted period (columns 3–4) are consistently larger in magnitude (more positive or less negative) than in the full-period models, indicating that results may be more pronounced when excluding the Christmas and festive season.

Table 4 DiD Estimation - Meatlike

	Full Period (1)	Full Period (2)	Restricted Period (3)	Restricted Period (4)
DiD	7.76735	7.76735	19.6951**	19.6951**
	(5.50465)	(7.46977)	(6.7104)	(6.78594)
Treatment	-133.52881***	-133.52881***	-133.5288***	-133.5288***
	(3.97253)	(15.93902)	(3.9853)	(4.03017)
Daily FE	Yes	Yes	Yes	Yes
Weekday FE	No	Yes	No	Yes
Observations	486	486	274	274
Adj. R^2	0.838704	0.834586	0.869088	0.862999
Avg. DV	81.45	81.45	73.83	73.83

*The dependent variable "Meatlike" is the average quantity sold (in kilograms) per day during the specified period. Standard errors are clustered at the fixed effect level. Standard errors in parentheses. ***p < 0.01, **p < 0.05, p < 0.1.*

Table 5 DiD Estimation - Not Meatlike

	Full Period (1)	Full Period (2)	Restricted Period (3)	Restricted Period (4)
DiD	-9.87349	-9.87349	5.9131	5.9131
	(6.49329)	(8.53807)	(7.76098)	(7.84834)
Treatment	-190.92072***	-190.92072 ***	-190.9207***	-190.9207***
	(4.89054)	(21.53938)	(4.90627)	(4.96150)
Daily FE	Yes	Yes	Yes	Yes
Weekday FE	No	Yes	No	Yes
Observations	486	486	274	274
Adj. R^2	0.886479	0.883581	0.898746	0.894036
Avg. DV	13.31	13.31	12.21	12.21

*The dependent variable "Not Meatlike" is the average quantity sold (in kilograms) per day during the specified period. Standard errors are clustered at the fixed effect level. Standard errors in parentheses. ***p < 0.01, **p < 0.05, p < 0.1.*

Table 6 DiD Estimation - Vegeterian Fish

	Full Period (1)	Full Period (2)	Restricted Period (3)	Restricted Period (4)
DiD	-15.4719 *	-15.4719	-1.81319	-1.81319
	(6.81282)	(8.50791)	(8.38691)	(8.48132)
Treatment	-199.8005***	-199.8005 ***	-199.80051***	-199.80051***
	(5.10747)	(22.97202)	(5.12390)	(5.18158)
Daily FE	Yes	Yes	Yes	Yes
Weekday FE	No	Yes	No	Yes
Observations	486	486	274	274
Adj. R^2	0.886961	0.884075	0.897557	0.892793
Avg. DV	1.02	1.02	0.96	0.96

*The dependent variable "Vegetarian Fish" is the average quantity sold (in kilograms) per day during the specified period. Standard errors are clustered at the fixed effect level. Standard errors in parentheses. ***p < 0.01, **p < 0.05, p < 0.1.*

Table 7 DiD Estimation - Tofu/Tempeh

	Full Period (1)	Full Period (2)	Restricted Period (3)	Restricted Period (4)
DiD	-13.6607*	-13.6607	-0.90075	-0.90075
	(6.52379)	(8.69048)	(8.02189)	(8.11219)
Treatment	-192.5428***	-192.5428 ***	-192.54282***	-192.54282***
	(4.90829)	(21.86933)	(4.92408)	(4.97951)
Daily FE	Yes	Yes	Yes	Yes
Weekday FE	No	Yes	No	Yes
Observations	486	486	274	274
Adj. R^2	0.88909	0.886258	0.899094	0.894401
Avg. DV	9.38	9.38	8.5	8.5

*The dependent variable "Tofu/Tempeh" is the average quantity sold (in kilograms) per day during the specified period. Standard errors are clustered at the fixed effect level. Standard errors in parentheses. ***p < 0.01, **p < 0.05, p < 0.1.*

Table 8 DiD Estimation - Vegetarian Charcuteries

	Full Period (1)	Full Period (2)	Restricted Period (3)	Restricted Period (4)
DiD	-14.9366*	-14.9366	-0.98879	-0.98879
	(6.7754)	(8.32428)	(8.32659)	(8.42032)
Treatment	-198.6024***	-198.6024 ***	-198.60240***	-198.60240***
	(5.0769)	(22.81852)	(5.09323)	(5.15056)
Daily FE	Yes	Yes	Yes	Yes
Weekday FE	No	Yes	No	Yes
Observations	486	486	274	274
Adj. R^2	0.88669	0.883797	0.897551	0.892786
Avg. DV	2.54	2.54	2.41	2.41

*The dependent variable "Vegetarian Charcuteries" is the average quantity sold (in kilograms) per day during the specified period. Standard errors are clustered at the fixed effect level. Standard errors in parentheses. ***p < 0.01, **p < 0.05, p < 0.1.*

6. Discussion

This chapter discusses the key findings of the analysis, situating them within both the empirical context of consumer behaviour and the broader academic literature. Section 6.1 interprets the observed sales patterns in response to the green shelf intervention, with particular attention to seasonality and consumer demographics. Section 6.2 compares the results to similar supermarket-based nudging studies, highlighting both methodological parallels and novel contributions. Finally, Section 6.3 outlines the main limitations of the study and proposes directions for future research to deepen understanding of nudging interventions in retail environments.

6.1 Unpacking Consumer Response to the Green Shelf

The event study results reveal three notable dynamics regarding the impact of the green shelf nudge on plant-based product sales. Firstly, the pre-intervention coefficients are statistically insignificant, which supports the validity of the parallel trends assumption. This is particularly relevant considering that the descriptive statistics indicated substantial baseline differences in average quantities sold between the control group (legumes) and the treated plant-based categories. The fact that the parallel trends hold despite these baseline differences strengthens the internal validity of the design and confirms that the fixed effects and control structure effectively isolate the treatment effect from potential confounders.

Secondly, while the majority of post-intervention coefficients are also insignificant, this pattern aligns with the overall DiD results and suggests a limited long-term effect of the intervention. However, the weeks immediately surrounding Christmas - specifically the week prior to and following December 25th - stand out as exceptions. During these weeks, the event study coefficients are significantly different from zero, indicating a short-term treatment effect that coincides with the festive season. These deviations underscore that consumer responsiveness to the nudge is not consistent across time but is instead moderated by seasonality and culturally significant periods. Importantly, after the dip observed in January, the sales trend for plant-based categories begins to rise again across February and March. This upward movement suggests the possibility of a delayed or sustained long-term effect of the green shelf nudge, which may become more visible once the immediate impact of the holiday season and post-festivity economic slowdown are excluded.

This seasonality effect can be attributed to deeply rooted Swedish culinary traditions. Traditional Christmas meals such as *julskinka* (Christmas ham), *köttbullar* (meatballs), *Jansson's frestelse* (anchovy and potato casserole), and *lutefisk* (dried and rehydrated cod) are predominantly meat- and fish-based. Historically, pork consumption during Christmas stems from autumn pig slaughter customs and the luxury of fresh meat reserved for the holiday season. These foods are not only staples of holiday meals but are also closely tied to national identity and familial rituals. The prevalence and cultural significance of these animal-based dishes may explain why the green shelf nudge had limited traction during this period.

Thirdly, the downward trend in sales across all five treated plant-based categories persists throughout January. This finding is somewhat surprising given the growing popularity of the "Veganuary" campaign, which encourages consumers to adopt a plant-based diet for the month of January and has gained considerable traction across Europe and North America. One might reasonably expect a rebound in sales of plant-based alternatives following the Christmas period as consumers shift toward healthier, sustainable eating habits. However, this expectation is not reflected by the data.

A likely explanation lies in the local consumer demographics of ICA Maxi Nacka. Nacka Municipality is an affluent and highly educated suburb of Stockholm with a population that is predominantly composed of working-age adults, families, and a notable proportion of seniors (Urbistat, 2024; CityPopulation.de, 2024[3]). The average age in Nacka is approximately 39 years, and nearly 40% of residents hold tertiary degrees, yet it is not a student-dense or youth-dominated area. These demographics suggest that consumers shopping at ICA Maxi Nacka may be less susceptible to social media-driven campaigns like Veganuary, which tend to resonate more strongly with younger populations, particularly university students and urban millennials. As a result, the post-Christmas decline in sales of plant-based items may reflect a reversion to established consumption patterns among older or more traditional consumers.

Furthermore, household consumption data at the national level confirms this post-festive economic slowdown. Statistics Sweden (SCB 2024) data show that January consistently records the lowest household consumption index across multiple years, whereas December reflects peak spending (SCB, 2024). This trend is also evident in the specific period under analysis: December 2020 sees the highest index values for both total household consumption and food-related retail, while January 2021 records the lowest values (see Appendix 2). This "January dip" can be interpreted as a reflection of post-holiday financial conservatism, where consumers cut back on discretionary spending following the high expenditures associated with Christmas. This pattern appears to disproportionately affect vegetarian goods compared to legumes, which aligns with the notion that many

[3] Urbistat and CityPopulation.de are secondary data sources used to provide descriptive context. While not official statistical authorities, they compile data from national sources and are suitable for general demographic insights.

plant-based substitutes are perceived as more premium or "luxury" items. As such, they are more sensitive to temporary reductions in spending power. Since overall seasonal trends are already controlled for through the inclusion of daily fixed effects, what the event study captures is not the general drop in consumption, but rather the relative difference between the treated categories and the control group. The stronger decline observed for vegetarian goods suggests that their consumption is more elastic[4] in response to economic constraints than that of legumes.

Together, the short-term effect of the nudge around Christmas, the muted impact of Veganuary, the broader seasonal spending contraction, and the post-January upward trend provide valuable context for interpreting the nuanced effect of the green shelf intervention. While the impact appears limited and temporally variable in the short term, the renewed increase in sales from February onward suggests that the nudge may indeed contribute to shifting consumer behaviour in a longer-term perspective, particularly once the influence of culturally and economically exceptional months is accounted for.

6.2 Positioning Within the Literature

This discussion draws on a specific subset of studies that share key methodological similarities with the present thesis, namely, supermarket-based interventions involving the strategic positioning of plant-based products. These include Vandenbroele et al. (2021), Coucke et al. (2019), Raghoebar et al. (2020), and Van der Meer et al. (2025). All four studies employed proximity-based nudges within either real or simulated supermarket environments, aiming to shift consumer behaviour toward plant-based alternatives. Notably, among them, only Coucke et al. (2019) explicitly considers the temporal context of their intervention. Conducted between March 5 and March 31, their study accounts for the proximity of Easter (an event associated with increased lamb purchases) by using control stores to mitigate holiday-induced sales variation. This contrasts with the other studies, which report positive or mixed results without factoring in any seasonal or festive influences. Importantly, Van der Meer et al. (2025), the only study with an intervention length comparable to this thesis, deliberately excludes the Christmas period from their analysis, underlining an implicit acknowledgment of its disruptive potential on consumption patterns.

In contrast, we introduce a novel perspective by capturing not only the short-term positive effects of a green-shelf intervention but also the nuanced role of seasonality. While the short-term coefficients are largely insignificant outside the

[4] Own-price elasticities calculated by the EPIC project support this interpretation. Vegetarian substitutes exhibit higher absolute elasticities - Meat-like (–0.800), Not meat-like (–1.548), Vegetarian fish (–1.817), Tofu/tempeh (–1.068), and Vegetarian charcuterie (–0.673) - indicating greater sensitivity to price and income changes. In contrast, Pure legumes show a relatively inelastic response (–0.366), consistent with their classification as staple goods.

festive period, the weeks surrounding Christmas exhibit statistically significant (positive and negative) treatment effects. This pattern, absent from the existing literature, highlights how culturally embedded food habits during holidays can overshadow behavioural nudges. Furthermore, while other studies conclude after their restricted intervention periods, the present findings reveal an encouraging rebound in plant-based product sales following the January slump. This trend suggests that the intervention may exert a delayed, potentially longer-lasting influence, particularly once external disturbances subside. Together, these comparisons underscore the contribution of this thesis in filling a gap in the current literature by demonstrating that seasonal dynamics and consumer traditions play a critical role in modulating the effectiveness of nudges. As such, this work not only confirms earlier findings under controlled conditions but also extends them by situating the intervention within a real-world, temporally complex retail context.

6.3 Limitations and Future Research

This thesis, situated within consumer studies and based on a quasi-experimental design, presents some limitations. A major constraint is the absence of a traditional control group unaffected by the treatment; instead, a food category from the same store (legumes) served as the control. Although legumes were not directly exposed to the green shelf nudge, indirect effects cannot be entirely ruled out. Moreover, the control group exhibited substantially higher baseline sales than the treated categories, which may affect the comparability in the DiD estimation. While the dataset covers an extended period, the sales dynamics observed from February onward suggest emerging trends that warrant further investigation, which would require additional post-treatment data. The green shelf also included food products beyond the five analysed categories, such as coconut milk, which were not explicitly captured in the analysis. While these items were not directly studied, they may have indirectly influenced consumer choices, for example, by inspiring meal ideas that could affect purchases of included categories like legumes. Such effects are likely limited, but their presence introduces some contextual variation that cannot be fully accounted for. Although macro-level factors cannot be entirely excluded, the DiD method, comparing shifts in sales between treatment and control groups relative to their baselines, offers the best available strategy to account for such external influences.

Future research should aim to replicate this analysis using data from multiple supermarkets and over a longer period to capture delayed effects. Expanding the study to other European countries would help assess the cultural sensitivity of the nudge. Additionally, estimating the long-term impact of such interventions would provide valuable insights for sustainable consumption policies. In particular, since the green shelf remains in place at the ICA Maxi Nacka store, a valuable and feasible line of future research would be to continue monitoring this intervention over time, offering a rare opportunity to evaluate its effectiveness in the long run.

7. Conclusions

This thesis investigates the impact of a supermarket-based nudging intervention, specifically, the introduction of a green shelf, on the sales of plant-based products in a real-world setting. By combining a DiD design with event study analysis, the study assesses both immediate and medium-term consumer responses while controlling for confounding seasonal dynamics. The findings suggest that the nudge exerts limited but temporally nuanced effects: sales increase modestly up to the festive period, continue to decline through January, and then rebound from February onward. This dynamic points to the potential for delayed behavioural shifts, shaped by cultural and economic rhythms. While the intervention appears insufficient to induce substantial or immediate changes across all product categories, it shows promise as a scalable, low-cost tool to support sustainable consumption.

Moreover, by highlighting the influence of seasonality and local demographics, the results underscore the importance of context in shaping consumer responses to nudges. The study contributes to the growing literature on behavioural interventions in food retail by extending the analysis to a longer timeframe and providing real-world evidence from a Swedish supermarket. Despite certain limitations, such as the lack of an unaffected control store and the potential for indirect effects, the thesis demonstrates that nudges like the green shelf can complement broader efforts to promote plant-based diets. Future research should explore long-term outcomes across multiple sites and cultural contexts to further evaluate the effectiveness and adaptability of such interventions.

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Popular science summary

What we eat has a major impact on both our health and the planet. Reducing meat consumption is widely recognized as a key step toward more sustainable and healthy lifestyles. But how can we encourage people to choose more plant-based foods without using rules or taxes? One promising solution comes from behavioural science: "nudging." A nudge changes the way choices are presented, making sustainable options easier to notice and select without taking away other options.

This thesis explores the effects of one such nudge: a "Green Shelf" introduced in a Swedish supermarket. The shelf grouped plant-based products together in a clearly marked, eye-catching space to attract shoppers' attention. Using sales data collected before and after the intervention, the study analysed how consumer purchases changed over time.

The results show that the nudge had some effect, particularly for products that mimic meat, right after the shelf was introduced. Sales increased up to Christmas, dropped in January, and began to rise again in February. These patterns suggest that seasonal habits and traditions, like holiday meals, strongly influence how effective such nudges can be. Still, the results also hint that even small, low-cost changes in how food is presented could help shift consumer habits in the long run. As the Green Shelf is still in place, continued research may offer further insights into how supermarket environments can support a transition toward more sustainable eating.

Appendix 1

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Adjoian et al. 2017) USA	Field study in 3 urban supermarkets in the South Bronx, New York City	Converted one checkout line per store into a "healthy checkout" by replacing impulse items with healthier snacks and beverages	2 weeks (1 week per checkout condition, with swap in week 2)	2,131 shopping parties observed (1,218 at healthy, 913 at standard checkout)	Direct customer observation and statistical tests (χ^2, *t*-tests)	Purchase rate and type (healthy/unhealthy/neutral) of items from checkout; per-customer item counts and spending	4% of customers bought checkout items; among them, healthy item purchases were significantly higher at healthy checkouts (56.5% vs. 20.5%, $p < .001$), while unhealthy item purchases were lower (45.7% vs. 74.4%, $p = .007$) Spending per 100 customers was slightly lower at healthy checkouts ($8.73 vs. $10.16) Healthy checkouts increased healthy purchases but had limited impact overall due to low checkout purchase volume.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Cheung et al. 2019) Netherlands	Field experiment at a take-away food vendor in a Dutch academic hospital	Three nudges: (1) Accessibility – relocating fruit to the front counter; (2) Salience – visually enhancing healthy bread rolls; (3) Social proof – labelling yoghurt shake as "bestselling choice"	7 weeks total (1 baseline, 1 nudge, 4 washouts, 1 nudge + disclosure)	All customers during the interventio n period; data from weekly electronic sales (no individual-level data)	t-tests, chi-square tests, and OLS regressions	Weekly sales of fruits, healthy bread rolls, and yoghurt shakes; comparisons with unhealthy alternatives	Accessibility nudge increased fruit sales (+73–82%), with effects persisting. Salience nudge had a small, non-significant effect. Social proof nudge had no effect. Disclosure did not reduce effectiveness.
(Coucke et al. 2019) Belgium	Field experiment in a real supermarket butchery with matched control store	Combined visibility nudge: increased display area size and quantity of poultry products; reduced display space for less sustainable meats	4 weeks (with 4-week pre- and post-measurement)	Not individual level; daily sales data by product (weight and revenue)	Three-way ANOVA with contrast tests	Daily meat sales (kg and revenue) across poultry, pork, and other meats	Poultry revenue rose by 18% (p = 0.018), then fell again (p = 0.022) No significant change in sales or revenue for other meats Nudge was effective in shifting choices toward more sustainable options without reducing total meat sales.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Elofsson et al. 2016) Sweden	Randomized controlled field trial in 17 Swedish grocery stores (Coop chain)	In-store information sign promoting climate-certified milk (qualitative carbon label)	4 weeks (with randomized weekly treatment-control rotation)	476 store-day observations across 17 stores; daily scanner sales data	Fixed effects OLS regressions with clustered standard errors	Sales of climate-certified milk (SEK), substitution with other milk, dynamic (lagged) effects	The label increased sales of climate-certified milk by 6–8%. Effects were driven by large stores; small stores showed no effect. No significant change in total milk sales or in other milk types. No dynamic (persistent) effects observed; nudge was short-lived.
(Gillebaart et al. 2023) Netherlands	Three studies: lab evaluation + two field experiments in Dutch supermarkets	Affordance nudge – animated character on a monitor placed behind vegetable shelf, using gaze and gesture to invite purchase	Study 1: lab evaluation Study 2: 2 weeks (1 control, 1 nudge) Study 3: 6 weeks (AB-AB-AB design)	Study 1 (n = 66); Study 2 (n = 151); Study 3 (n = 361 + sales data from 2 supermarkets)	Paired t-tests and repeated measures ANOVA	Study 1: Perceptions of the nudge Studies 2 & 3: Sales of nudged vegetables; shopper perceptions	Study 1: The character nudge was seen as inviting, effective, and non-patronizing. Study 2: Vegetable sales rose by 13% (non-significant), with stronger effects near the screen. Study 3: A significant 17% increase in vegetable sales, over time and across stores.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Grandi et al. 2021) UK	Online experimental study simulating retail environment (between-subjects design)	Shelf placement, simplified nutritional shelf labels, and nutritional clustering	One-time choice task	n = 284 participants	Logistic regressions with interaction terms	Product choice (selection of healthy vs. unhealthy items) in cereal and cereal bar categories	Simplified shelf labels increased healthy choices. Combining labels with vertical placement and clustering was most effective for cereal bars (low-habit product). Less impact observed in cereals (habitual product).
(Hughes et al. 2023) UK	Online randomised experiment with UK adult meat eaters	Pictorial warning labels highlighting health, climate, or pandemic risks of meat consumption (vs. control)	One-time, 20-trial hypothetical meal selection task	n = 1,001	Beta regression for primary outcome; GLM for secondary outcomes; bootstrapping for parameter estimates	Proportion of meat meals selected; label perceptions (credibility, emotional arousal, annoyance, etc.); policy support	All three pictorial labels significantly reduced meat meal selection vs. control (reductions of 7.4–10%). No significant differences between label types. Pandemic labels triggered stronger emotional arousal but were seen as less credible. Climate labels had higher public support, but overall support for labelling was mixed.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Kroese et al. 2016) Netherlands	Field experiment in 3 snack shops at a Dutch train station	Repositioning healthy snacks to the cash register area, with and without explanatory signage	2 weeks (1 baseline week + 1 intervention week)	3 shops (1 control, 1 nudge, 1 nudge + disclosure); customer survey: n = 91	Chi-square tests and descriptive analysis	Sales of healthy and unhealthy snacks; customer acceptance of the nudge	Placing healthy snacks near the checkout nearly doubled sales. Adding an explanatory sign had no additional impact. 85% of surveyed customers accepted the nudge positively. No decrease in unhealthy item sales was observed.
(Kurz 2018) Sweden	Field experiment at two university restaurants in Gothenburg	Reordered menu to place vegetarian dish first and made it physically more visible at point of choice	17 weeks intervention + 13-week reversal + 10-week baseline (full academic year)	Treated restaurant: 166 days of data; Control restaurant: 175 days of data	DiD with time fixed effects in regression models	Share of vegetarian dishes sold; persistent behaviour after intervention; substitution effects; estimated GHG emissions	The nudge increased vegetarian sales by 6 percentage points during intervention. Sales remained 4 pp higher after intervention, showing persistence. The nudge reduced meat 1 sales, slightly increased meat 2 sales, and cut food-related GHG emissions by ~5%.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Lohmann et al. 2022) UK	Large-scale field experiment in five university cafeterias (University of Cambridge, UK)	Carbon footprint labels on all main meals using traffic-light design and CO_2 values per 100g	7 weeks (following a 9-week baseline)	81,401 individual meal choices by 2,228 diners	DiD and mixed logit models	Meal choices (low/mid/high carbon), average emissions per meal, meat/fish vs. veg meals	Labels reduced high-carbon meal choices and increased mid-carbon ones. Average carbon emissions per meal fell by 4.3%. Meat/fish meal share decreased by 1.7 pp; veg meal share increased accordingly. Labels were perceived as useful and trustworthy; effects were stronger among high-carbon eaters.
(Peeters et al. 2022) Netherlands	Web-based experimental study using a digital meat membership platform ("Tomorrow's Menu")	Ethical choice architecture engaging System 1 and System 2 thinking: pre-shopping value reflection + in-store label cue and discount for sustainable meat	3-week multi-stage online experiment (t0–t3)	210 initial participants; 126 completed all phases	Logistic regression and chi-square tests	Choice of sustainable vs. unsustainable meat; value-behavior congruence based on biospheric values	Intervention increased sustainable meat choices (only 1% chose unsustainable meat in treatment vs. 18% in control). No significant improvement in value-action congruence. Results support ethical redesign of choice architecture to align with moral decision-making tendencies.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Raghoebar et al. 2020) Netherlands	Two experimental studies with Dutch non-vegetarian participants: Study 1: Online visual choice task Study 2: Lab-in-the-field with real product selection (women's fair)	Manipulated availability (more plant-based vs. animal-source options) while holding product range constant	Single exposure in both studies (one-time task)	Study 1: *n* = 184 Study 2: *n* = 276	Chi-square tests, ANOVAs, logistic regression, and mediation/ moderation analysis (PROCESS) to assess effects of availability on food choice and norm perceptions	Food choice (plant-based vs. animal-source), perceived salience, descriptive norms, injunctive norms, and meat attachment	No direct effect on food choice in either study. Availability influenced perceived descriptive norms (but inconsistently across studies). No effect on salience or injunctive norms. Effectiveness was limited by strong meat attachment and possible scarcity interpretations. Results suggest availability cues may shift social norm perceptions but not necessarily behaviour.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Taillie et al. 2021) USA	Online randomized experiment with US red meat consumers	Front-of-package health, environmental, or combined health/environment warnings on red meat products.	One-time experiment (June–July 2020)	*n* = 1,235	Logistic and OLS regressions; tested main effects and moderation (e.g. by meat intake, climate beliefs)	Choice of steak burrito, perceived harm, message effectiveness, believability, risk, emotions, attention, learning, and intent to reduce meat consumption	Warnings did not reduce selection of red meat item. Health and combined warnings increased perceived health harms and message effectiveness. Combined warning rated highest on perceived risk and learning. Environment warning was least effective across outcome. No differences in intentions to reduce meat intake.
(Van Der Meer et al. 2025) Netherlands	Field experiments in supermarkets (NL) + online lab study	Placement of selected meat substitutes into the meat shelf (vs. vegetarian shelf)	13 weeks (Study 1a), 28 weeks (Study 2)	Study 1a: 7 treatments, 33 control stores; Study 2: 294 stores; 481,803 loyalty card users	DiD and corARMA time-series regressions	Sales of meat substitutes and meat (weight sold); consumer perceptions (surveys/interviews)	Study 1a: Full relocation of meat substitutes to the meat shelf decreased sales. Study 2: Partial placement increased sales among omnivores/flexitarians without reducing meat sales; vegetarian shelf remained important for vegetarians.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Vandenbroele et al. 2021) Belgium	Field experiment in a supermarket (intervention vs. control stores) and follow-up lab study with 2×2 between-subjects design	Field: Meat substitutes added to the meat section while kept in the vegetarian aisle. Lab: Visibility and placement (next to meat vs. not) manipulated for sandwich spreads	1 month	Field: Retail loyalty card data from 9 stores Lab: n = 231 participants	Field: Poisson regression (sales data) Lab: Logistic regression	Field: Actual purchases of meat substitutes and meat Lab: Hypothetical product choice (plant- vs. meat-based spread)	Placing meat substitutes near meat in butchery increased sales by 171% in the intervention store. In the lab, both visibility and pairwise presentation increased selection of plant-based options; visibility was the stronger factor. No significant backfire effect on meat purchases.
(Vandevijvere & Berger 2021) Belgium	Natural experiment with 43 intervention and 14 control stores using 2018-19 pre-post panel data	Introduction of electronic shelf labels (ESL) displaying Nutri-Score (A–E) at product level across all categories	Average = 173 days (range 85–218 days)	Scanner data from >50 stores, covering 58 food categories	DiD with linear mixed models	Weekly product sales by Nutri-Score level (A to E), total nutritional quality of purchases per store	Mixed effects: Healthier purchasing in 17 of 58 categories; 16 worsened, 20 unchanged. No significant impact on meat/fish. Labels had limited effect; stronger when paired with pricing or education.

Author(s) Year Country	Setting / Design	Intervention	Duration of Intervention	Sample Size	Method	Measured Outcome	Main findings
(Vasiljevic et al. 2024) UK	Field experiments in two UK university dining halls using multiple treatment reversal design (ABACA format)	Gain-framed warning labels on meat: College A: Text-only vs. text+image environmental labels. College B: Text+image health vs. environmental labels	5 weeks total (interventions alternated weekly)	13,869 meals recorded (6,577 College A; 7,292 College B); post-study survey: n = 88 (A), n = 53 (B)	Beta-binomial regression; ternary plots and non-parametric bootstraps for survey data	Daily proportion of meat meals selected; post-survey perceptions (e.g. attention, informativeness, guilt, learning)	No significant effect of any label on meat consumption. Number of non-meat options consistently predicted lower meat selection. Text+image labels perceived as more informative and emotive but did not change behaviour. Patrons reported no new learning and no expected change in habits.
(Winkler et al. 2016) Denmark	Community-based supermarket field intervention in four Danish Coop stores	Replaced sugar confectionery at one checkout with fruit and healthy snacks	4 weeks	Sales data from 28 stores; 48 customer exit interviews	Linear mixed models; qualitative thematic analysis	Sales of healthy snacks (e.g. carrot packs), sugar confectionery; customer perceptions	Intervention was well received but had low visibility. Carrot snack sales rose, no effect on other items or confectionery. Modest impact but seen as a win-win signal of store responsibility.

Appendix 2

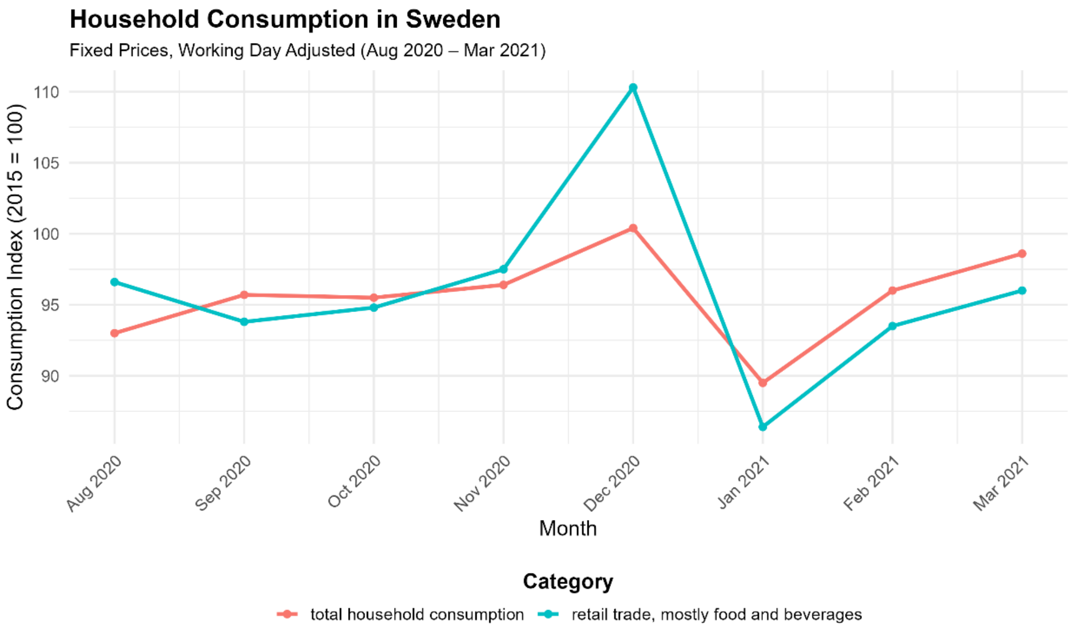

Figure 8 Monthly household consumption index in Sweden (Aug 2020–Mar 2021), fixed prices and working day adjusted. December shows peak spending, followed by a January drop and gradual recovery. Source: Statistics Sweden (2024).

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