Università degli Studi di Padova

Administrative unit: University of Padova

Department: **Land, Environment, Agriculture and Forestry (TESAF)**

PhD Program: **Land, Environment, Resources and Health (LERH)**

Batch: XXXVI

Understanding the impact of the Front-Of-Pack nutrition labelling system on consumers' choices and preferences. The case of the Nutri-Score applied to Geographical Indications

PhD Program Coordinator: Prof. Marco Borga

Supervisor: Samuele Trestini

PhD candidate: Alice Stiletto

Università degli Studi di Padova

Sede Amministrativa: Università degli Studi di Padova

Dipartimento Territorio e Sistemi Agro-Forestali (TESAF)

CORSO DI DOTTORATO DI RICERCA: **Land, Environment, Resources, Health (LERH)**

Ciclo: XXXVI

Comprendere l'impatto dell'etichettatura nutrizionale fronte pacco sulle scelte e le preferenze dei consumatori. Il caso del Nutri-Score applicato alle Indicazioni Geografiche

Coordinatore: Prof. Marco Borga

Supervisore: Prof. Samuele Trestini

Dottoranda: Alice Stiletto

Contents

List of Figures

List of Tables

Abbreviation and acronymous

NCD	Non-Communicable Diseases
FOP(L)	Front Of Pack (labels)
NS	Nutri-Score
F2F	Farm to Fork
GI(s)	Geographical Indication (products)
PDO	Protected Designation Of Origin
PGI	Protected Geographical Indication
WTP	Willingness To Pay
DCE	Discrete Choice Experiment
EA	Experimental Auction
BOP(L)	Back of Pack (labels)
MTL	Multiple Traffic Lights (label)
HPM	Hedonic Price Model

Summary

Food and health are strictly intertwined concepts, with obesity and overweight emerging as some of the most pressing nutritional challenges worldwide. Indeed, according to the World Health Organization (WHO) statistics, in 2022, approximately 59% of adults and nearly one in three children were overweight or obese in the European context, causing over 1.2 million deaths. The prevalence of obesity in Europe is higher than in all the other regions, except for the Americas, forcing governments and institutions to adopt different strategies to mitigate and contain the problem. The European Commission has indeed outlined an integrated approach to reduce health issues caused by overweight and obesity, contrasting the obesogenic environment and reducing high-risk behaviors, such as improper dietary habits and lack of physical activity. In this context, Front-of-Pack (FOP) nutritional labels play a fundamental role, as they are intended to help consumers make healthier food choices easily and quickly. Through the Farm to Fork Strategy, the European Commission had initially set the goal of adopting a single mandatory FOP nutritional label, consistent across all Member States, by 2022.

Among the various nutritional labels currently adopted in the European context, the Nutri-Score (NS) seemed to be the most scientifically supported due to its ease of understanding. However, due to strong opposition to this labeling system, raised by major food industries and some politicians, especially at the Italian level, the European Commission was unable to choose which Front-of-Pack label to adopt at the Union level, with a consequent delay in the decision to the next European legislature. In fact, NS seems to "not ensure correct and complete information for consumers," as reported by the European Food Safety Authority (EFSA), while also potentially harming typical and traditional products, such as Geographical Indications (GIs). Despite the importance of delving into this issue, the scientific literature has not investigated the reasons behind this decision, making it even more challenging for the European Commission to make a cohesive and robust decision. This thesis aims to clarify this issue by outlining the state of the art regarding the NS debate at the European level, highlighting the differences between public opinion and scientific literature, and bringing to light the areas not investigated enough by scientific research (Chapter 3), after introducing the NS topic (Chapter 1), also considering its normative framework (Chapter 2). The contrast between NS and GIs has emerged as the main topic of discussion at the public and political levels, although it has not been adequately investigated by scientific literature. To bridge this gap, this thesis seeks to clarify the issue by analyzing consumer preferences for various GIs labeled with NS (Chapters 4 and 5), while also examining the real implications of this nutritional label on the prices and sales of GIs products (Chapter 6).

Sommario

Obesità e sovrappeso stanno minando il futuro dell'Europa. Infatti, secondo le statistiche dell'OMS (Organizzazione Mondiale della Sanità), nel 2022 circa il 59% degli adulti e quasi un bambino su tre erano in sovrappeso o affetti da obesità nel contesto europeo, causando più di 1.2 milioni di decessi. La prevalenza di obesità in Europa è più alta che in tutte le altre Regioni dell'OMS, fatta eccezione per l'America, costringendo governi e istituzioni ad adottare repentinamente diverse strategie per mitigare ed arginare il problema. La Commissione Europea ha infatti definito un approccio integrato per ridurre i problemi sanitari causati da sovrappeso e obesità, combattendo l'ambiente *obesogenico* e riducendo i comportamenti ad alto rischio, come ad esempio l'alimentazione scorretta e la mancanza di attività fisica. In questo contesto, giocano un ruolo fondamentale le etichette nutrizionali Fronte-Pacco (le così dette etichette Front-Of-Pack), che dovrebbero aiutare i consumatori a fare scelte alimentari più salutari in modo facile e veloce. La Commissione Europea, attraverso la Strategia Farm To Fork, si era prefissata di adottare, su base obbligatoria ed entro il 2022, un'unica etichetta nutrizionale Fronte Pacco, che fosse omogenea in tutti gli stati membri. Fra le varie etichette adottate nel contesto europeo, il Nutri-Score (NS) sembrava essere la più sostenuta a livello scientifico, perché di facile comprensione.

Tuttavia, a causa di forti opposizioni a questo sistema di etichettatura, sollevate dalle maggiori industrie alimentari e da alcuni politici, soprattutto a livello italiano, la Commissione Europea non ha potuto scegliere quale etichetta Fronte Pacco adottare a livello Comunitario, rinviando la decisione alla prossima legislatura europea. Infatti, il Nutri-Score sembra "non assicurare una corretta e soprattutto completa informazione ai consumatori», secondo quanto riportato dall' Autorità europea per la sicurezza alimentare (EFSA), danneggiando al contempo i prodotti Tradizionali, come le Indicazioni Geografiche. Nonostante l'importanza di approfondire questo tema, la letteratura scientifica non ha sufficientemente indagato circa le motivazioni che hanno portato a questa decisione, rendendo ancora più difficile per la Commissione Europea prendere una decisione coesa e robusta. La presente tesi di propone quindi di far chiarezza sull'argomento, delineando lo stato dell'arte sul NS a livello europeo, evidenziando le differenze esistenti fra opinione pubblica e letteratura scientifica e mettendo in luce quali sono le zone d'ombra non sufficientemente investigata dalla ricerca scientifica (Capitolo 3). Il contrasto fra NS e Indicazioni Geografiche è emerso essere il principale oggetto di discussione a livello pubblico e politico, anche se non adeguatamente investigato dalla letteratura scientifica. Per contribuire a colmare questo divario, la presente tesi ha cercato di fare chiarezza sulla questione, stimando le preferenze dei consumatori per diverse Indicazioni Geografiche etichettate con NS (Capitoloi 4 e 5) e analizzando al contempo, l'effetto che questa etichetta nutrizionale ha su prezzi e vendite di dei prodotti tipici e tradizionali (Capitolo 6).

Chapter 1

Introduction

Nowadays, international authorities are adopting policy strategies enhancing dietary behaviours of the citizens, with the aim to prevent Non-Communicable Diseases (NCDs), one of the key problems of the XXIst century (Ng et al., 2014). Among the others, obesity stands out as a prominent nutritional challenge, with a staggering 200% increase observed between 1975 and 2016 (WHO, 2020a). Modifiable risk behaviours, such as unhealthy diets and physical inactivity, are found to be one of the main causes of obesity. Hence, Public Health interventions targeted at modifiable risk factors are urgently needed, being considered a relevant approach to tackle NCDs.

In this context, informed purchasing choices became a global priority, considering that nutritional labelling has been identified as a crucial aspect in consumer decision making. Thus, its use has been strongly recommended as a strategy to promote healthier dietary behaviours (Morgane Fialon et al., 2020; Hawkes & Popkin, 2015), especially in Mediterranean countries (Capacci et al., 2012). Nevertheless, literature pointed out that consumers tend to give limited attention to nutritional labels due to several factors. These factors include the inconspicuous location of Front-Of-Pack (FOP) labels on food packages (Graham et al., 2017), time constraints when shopping (Grunert et al., 2010), and consumers' limited comprehension of the Nutrition Facts (Campos et al., 2011). As a result, consumers often struggle to utilize this information when making purchasing decisions, with a clear discrepancy between declared and revealed behaviour. While approximately 40% of consumers state to rely on nutritional labels during purchases (Delamaire et al., 2008), only 10% actually do so when observed during in-store studies (Grunert et al., 2010). Hence, an easier-to-understand version of the nutritional labelling has been widely promoted through FOP labels, i.e., graphic labels placed in front of the package which give information about the nutritional profile of the food.

At the European Union level, a broad array of FOP labels is presently in use (Storcksdieck Gennat Bonsmann et al., 2020). Examples include the Green Keyhole in Scandinavian Countries, the NutrInform battery in Italy, the Traffic Light labels in Spain and Portugal, or the Nutri-Score (NS), adopted for the first time in France in 2017, and now widely spread in Europe. Most of them are Nutrient-specific labels (such as the Traffic Light Label or the NutrInform battery), which typically highlight the content of energy, saturated fat, sugar, sodium, and salt per

serving. Despite being valuable for drawing consumers' attention to excessive consumption of harmful nutrients, these labels seem not to be the best solution when differentiating healthier and less healthy foods, within a spectrum of dietary options (Temple, 2020). On the contrary, summary labels (as NS) are considered more efficient than other FOP labels to allow consumers to classify products according to their nutritional quality (Ducrot et al., 2015a), using an algorithm to translate the components of the food into a single value that denotes how healthy or unhealthy it is (Temple, 2020).

So far, the adoption of these FOP nutrition labels has not been mandatory yet for firms and retailers, with the European Commission committed to establish a unique and harmonized FOP label to be used in all member states within 2022, according to the Farm to Fork strategy goals. To this purpose, France proposed the adoption of the Nutri-Score at the Community level, supported by the European Committee of the Regions. To reinforce this decision, most of the scientific community has come out in favour of the NS, with several studies highlighting the effectiveness of this nutrition label in guiding consumer choices towards healthier products (see, among others, Ducrot et al., 2015b; Fuchs et al., 2022; Julia et al., 2016; Shin et al., 2023). However, the proposal for the NS as the standardized EU nutrition label to be adopted is facing delays, due to political disagreements and disputes between governments and firms, with a consequential shift of its implementation to the next legislature (Stiletto et al., 2023).

The NS is a five-step color-graded nutrition label, reporting the nutritional value of 100 g of the product by using jointly a chromatic and alphabetical scale. It considers the content of nutrients and foods that should be consumed more frequently, namely fruits and vegetables, fiber, proteins, nuts, rapeseed and olive oils, and the content of nutrients and foods that should be limited in consumption, such as energy, saturated fatty acids, sugars, and salt. According to the seminal paper of Julia & Hercberg (2017), consumers should be able to compared products according to their NS level, thus choosing the healthiest option within the category. Nevertheless, some food categories receive, as a whole, unfavorable evaluations from this nutrient profiling system. It is the case of products of animal origin, notoriously high in calories and rich in saturated fat content (Stiletto & Trestini, 2022), thus complicating for consumers the identification of the best product in the category. Despite it seems to be in contrast with the initial objectives of the NS label, this classification system aligns with the principles of the Mediterranean Diet, which advocates moderate consumption of animal origin products (Vlassopoulos et al., 2022).

Recent literature (see for instance Stiletto & Trestini, 2022) has highlighted that products receiving negative NS ratings often face market challenges, as consumers are willing to pay less prices for them, potentially leading to decreased prices and volumes for these products. Although this price reduction aligns with market dynamics and with the goals of the Green Deal and Farm to Fork (F2F) strategy, it may present a hurdle for Geographical Indication (GI) products (Chantal et al., 2022), generally promoted and protected by the EU for their superior quality, as regulated by Reg. 1151/2011. This certification system enables producers to market their products more effectively, with value premiums of 1.5 times for agricultural products and 2.85 times for wines, as reported by the European Commission (2020b). Additionally, GIs play a pivotal role in fostering local economic development, a core aspect of the F2F strategy, aimed at building a resilient food system and ensuring fair incomes for producers (Crescenzi et al., 2022).

However, most of GIs, being of animal origin, generally receive unfavorable NS ratings, even if they are less likely to contain food additives and to be ultra-processed[1] (Höhn et al., 2023). Besides, these animal origin products account for approximately 52% of the market share, with Italy the leading country in terms of registered GIs (Török & Moir, 2018). In Italy, nine out of the top ten GIs by production value are of animal origin, constituting 85% of GI production value and 40% of the national exports of animal origin products (ISMEA, 2021). As a result, the effect of the NS adoption on GIs seems to be a double trouble, highlighting inconsistencies not only between policies (F2F and GI policy), but also within the same strategy, with the F2F promoting the GIs on the one hand and damaging most of these products on the other one.

In a broader context, it can be inferred that the European Union is concurrently promoting two divergent policies. On one hand, the F2F strategy, particularly within the realm of social sustainability related to nutritional aspects, advocates the adoption of the NS at the European level. On the other hand, the EU GI policy lends its support to PDO (Protected Designation of Origin) and PGI (Protected Geographical Indication) products due to their superior quality, rooted in their connection to specific regions and traditional know-how. Although these two policies address distinct facets, with the F2F strategy endorsing the

[1] Ultra-processed foods are generally recognized by nutrition researchers as low-quality foods, having increasing implications with poor dietary quality, and with adverse metabolic and health outcomes within a range of populations and country contexts (Elizabeth et al., 2020).

healthiest products via the NS and the GI policy championing the quality of regionally protected items linked to local traditions, the outcomes are nonetheless at odds.

Indeed, PDO products are commended by the GI policy while facing criticism under the F2F strategy. This duality creates confusion among consumers and underscores the potential paradox in the EU legislative proposal. Furthermore, the F2F strategy, which encompasses all dimensions of sustainability, also emphasizes other aspects of social sustainability, such as support for the local economy, aligning with the principles of the GI policy. Therefore, supporting the NS at EU level would reveal, to some extent, an internal inconsistency of F2F.
In light of this, there is a crucial need to understand which is the impact of the Nutri-Score on consumers' purchasing choices and specifically which is the effect of this labelling system on GI products. Being Italy the European leader in certified quality products (with 302 products certified), and with an export value more than € 9 billion in 2018, which is still growing, it becomes a particularly valuable case study.

Nevertheless, current research tends to overlook these aspects, even if they are much debated at the public level. To decide what FOPL to adopt at the EU level, the European Commission needs to have a complete overview of the NS topic, evaluating all its aspects. In this respect, it is important to take an informed policy decision, gaining insights about the most relevant aspects raised by citizens and researchers. Also, the efficacy of the labels should be tested in different market, considering the countries in which consumers have low familiarity with the label, with the NS not adopted yet in these regions.

To align with this perspective, this work aims to broaden the body of knowledge on consumer perception of FOP labels and to assess the Nutri-Score effect on the internal market, as required by Article 5 of Regulation (EU) n. 1169/2011 and underlined by the European Commission. More in depth, the present study aims to (see also Figure 1.1 for a graphical representation):

1. provide an overview on the Nutri-Score discussion in Europe, highlighting to what extent scientific research has addressed the concerns raised by public opinion (Objective 1);
2. determine consumers' preferences and their willingness to pay (WTP) for GI (and conventional) products when labelled with Nutri-Score, compared to the same products without this FOP label (Objective 2);
3. determine the effect NS on the real market, especially considering GI products (Objective 3).

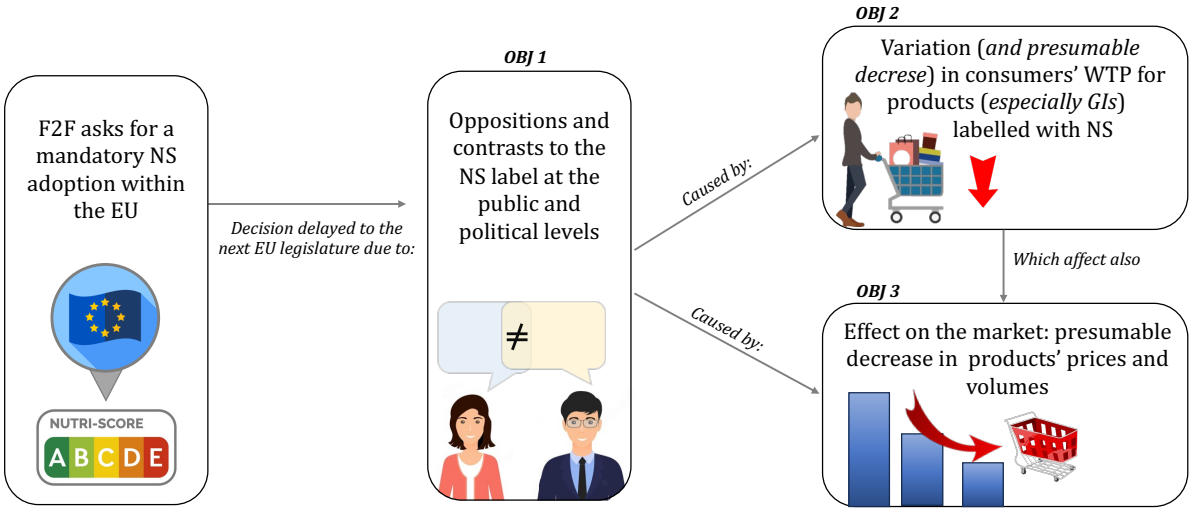

Figure 1.1 Graphical representation of the research objectives

To achieve these objectives, different methodologies, described more in details in the following chapters, were implemented. To address the first objective, thus highlighting what are the main topics discussed at the public level regarding the NS and finding out the main shortcomings at the scientific level, a topic modelling analysis has been conducted on both tweets and on scientific studies. Specifically, a Twitter analysis has been performed in four different EU countries: France, Germany, Italy, and Spain, to understand the public opinion on NS at the European level. Indeed, Twitter is considered the social network platform most used by institutions, industries, and organizations for disseminating information and engaging in legislative discussions (Bilal & Oxentenko, 2020), being therefore the most suitable tool to catch the public discussions on this topic. Besides, a topic modelling analysis has been performed on scientific articles published on the NS. To understand if the scientific literature has covered all the aspects emerged from the public debate, thus providing the European Commission with an appropriate overview on the NS topic, a comparison between the topics emerged from the tweets analysis and those emerged from the scientific research has been conducted.

Then, to assess Italian consumers' preferences and determine their willingness to pay for NS labelled products, two different methodologies have been implemented: a Discrete Choice Experiment (DCE) and an Experimental Auction (EA) analysis. Using two different techniques for eliciting consumer preferences can provide a more comprehensive understanding of consumer behaviours and preferences in different contexts. DCE are usually tailored to explore specific attributes or scenarios, providing a detailed understanding of

consumer preferences, especially when market transaction data have limitations or do not exist in a form useful for measurement of economic values (Holmes et al., 2017). Being the NS not adopted yet in Italy, there are no products (especially considering GIs) labelled with the NS in the Italian market. Therefore, the evaluation of consumers' preferences should be conducted on a hypothetical context. Nevertheless, literature frequently pointed out the limitations of this scenario, as consumers tend to overestimate the amount they are willing to pay in hypothetical settings, especially if compered to non-hypothetical experiments (List & Gallet, 2001). Hence, to overcame this limitation, an EA has been conducted along with the DCE, being one of the methodologies most used in the economic field to create incentive compatible assets, thus pushing people to reveal their "true" preferences (Lusk et al., 2007). Moreover, as Italian consumers are not familiar with the NS, respondents in the EA were provided with information on both the nature of NS and its calculation system, aligning with the guidelines outlined by the French Ministry of Health. Combining these methodologies allows to explore consumer preferences in different contexts, enhances the robustness of the research.

Finally, in line with the overall objective of the EU Commission and considering the lack in literature in analyzing the effect of the NS on market sales (Ahn & Lee, 2022; Mora-García et al., 2019) a hedonic price analysis has been performed. GI and conventional animal products are considered in the analysis, with the aim to understand the effect of the use of the NS label on retail French market prices. As mentioned before, there are no market data available in the Italian context. For this reason, the hedonic price analysis has been performed considering the French market, being the "motherland" of the NS label.

The thesis is structured as follow:

- The research background is presented in ***Chapter 2***. A brief introduction about the use and significance of Front-Of-Pack (FOP) labels will precede a detailed description of the NS system, highlighting pros and cons of the label, also considering its impact on Geographical Indications.
- ***Chapter 3*** details the topic modelling analysis, comparing the most debate topics emerged at the scientific and public levels.
- Consumers' preferences and Willingness to Pay for NS labelled products in Italy are presented in ***Chapter 4***, which reports the Discrete Choice Experiment results.
- Similarly, in ***Chapter 5*** are detailed the results of the Experimental Auction analysis, conducted on 200 Italian consumers.

- Finally, in ***Chapter 6*** some general discussions and conclusions are drawn, mainly focusing on the policy implications.

Chapter 2

Front of Pack labels in the EU: the case of Nutri-Score

2.1. The Front Of Pack context

Food labels are generally considered the *sine qua non* of consumers' conscious food choices, even if both consumers and producers can benefit from the correct use of this tool. From the producer's perspective, labels became an essential tool not only to pass the essential information to consumers, but also to enable them to highlight the benefits of their products when compared to those of their competitors. From the consumers' point of view, labels allow them to make an informed choice at the point of sales (European Commission, 2006). In the last decades, both national and international authorities drafted guidelines to guarantee a greater level of knowledge to consumers. The European Parliament and the Council of the European Union issued Regulation (EU) n. 1169/2011, intended to help consumers during their purchase decision. Producers have to provide complete and easy to understand information on their products (e.g., the origin of the product or the nutritional profile), with the aim to provide consumers with all the elements they need for their conscious choice, with respect to health-related, economic, and social/ethical aspects.

The scientific community has worldwide recognized the value of labelling as a tool to reduce information asymmetry and to protect consumers. Specifically, Shangguan et al. (2019) recently demonstrated the ability of food labels to inform consumers, significantly improving the healthiness of their diet. In the past decades, the Back Of Pack (BOP) were the only labels in common used to signal the nutritional properties of foods. However, as previously discussed, consumers have generally a poor ability to precisely interpret these labels (Cowburn & Stockley, 2005). Therefore, a new version of the nutritional labelling has been promoted through Front-Of-Pack labels, which are graphic labels placed in front of the package, which give information about the nutritional profile of the food in an easier way.

Multiple schemes of FOP label co-exist in Europe and are currently used (see Figure 2.1. for some examples). Some of these are nutrient-specific labels and provide consumers with

information on the content of specific substances of the product, such as saturated fat, sugar, and salt. Within this group there are the Guideline Daily Amounts (GDA) and its slight variation, namely the Reference Intake label (Food and Drink Federation, 2019)[2], as well as the Multiple Traffic Lights (MTL), promoted by the Food Standard Agency[3] and currently used in many countries, such as the UK. Within the nutrient-specific group there are also the so-called Warning Labels, adopted for the first time in Chile in 2016, which aims to signal the high content of an undesirable ingredient (e.g., sugar or salt). These FOP are largely spread out of the EU context, especially in Brazil, Canada, and several US states. As an alternative to the nutrient-specific labels, some countries support the summary labels, which provide a general nutritional evaluation of the product in a simple way (e.g., with stars or colours), allowing consumers to make quick and easy choices. Through the use of an algorithm, the content of the different food components was translated into a single value, which represents the degree of healthiness of the product. Considering that consumers generally spend only few seconds to choose products when shopping, these simple labels could be more useful for consumers. Indeed, Sanjari et al. (2017) found that FOP labels are generally preferred over the BOPLs by consumers, being easier to understand. Also, within the FOP labels spectrum, consumers tend to prefer the simplest, as the Guiding Stars[4], mainly used in the USA, the Health Star Rating system (HSR), promoted by the Australian Government Department Health[5], and the Nutri-Score, adopted for the first time in France in 2017.

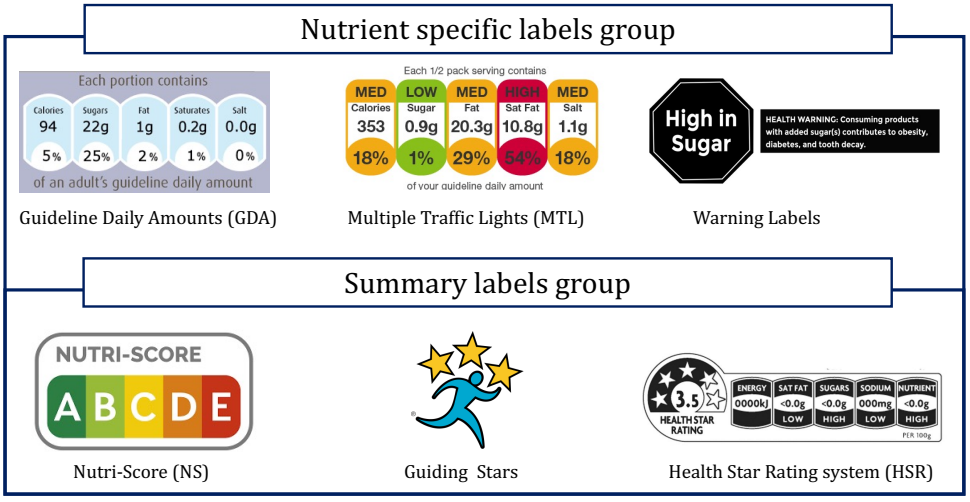

Figure 2.1. Examples of FOP labels

[2]Available at: http://www.foodlabel.org.uk/label/ gda_values.aspx
[3] Available at: https://www.gov. uk/government/publications/front-of-pack-nutrition-labelling-guidance
[4] https://guidingstars.ca/about
[5] Available at: http://foodregulation.gov.au/internet/ fr/publishing.nsf/Content/front-of-pack-labelling-1

However, the results obtained in some specific countries may not be easily generalizable, due to the lack of external validity, typical of consumer studies (Lynch Jr, 1982). Indeed, consumers' familiarity with the labels is one of the key factors in explaining their efficiency and efficacy. As reported by Santos et al. (2020), the effectiveness of the FOP label is context-dependent, with consumers usually preferring the FOPLs already implemented in their countries, at the expense of the new ones, due to the higher familiarity with them. Indeed, despite recent studies pointing out that Nutri-Score (Egnell et al., 2018; Julia, Blanchet, et al., 2016) and Health Star Rating system (Neal et al., 2017) are the most effective in guiding consumers towards healthier food choices, MTL is found to be the best option to support Portuguese consumers' healthier purchasing choices, due to the greater familiarity with it (Santos et al., 2020). The same goes for the Italian consumers, who largely prefer the NutrInform battery (Mazzù et al., 2020) or the MTL (Morgane Fialon et al., 2020) over the NS, considering the NS label less intuitive and informative (Mazzù et al., 2020).

Yet, the lack in consistency found in literature suggests that there is no FOPL that absolutely performs better than the others. Generally, it can be assumed that each country prefers a specific FOP label over the other, which is more closed with the preferences of their respective consumers. Nonetheless, the European Union aims to prevent the use of different FOP labels across its member states. This objective is in accordance with the F2F Strategy, which emphasizes the necessity of implementing a standardized FOP label across all European countries by 2022. When selecting the FOPL to adopt, the EU Commission will presumably prefer the label performing better than the others in relative terms, being utopic to have a FOPL without weak points or contradictions. In this context, the NS (together with the MTL) seems to be the best candidate, as it is the most effective label in the majority of the research outcomes (Temple, 2020). However, as stressed in the introduction, to reach the F2F objectives a clear evaluation of the NS efficiency is needed in all the EU countries, especially considering those not familiar with it, as Italy. Also, although most studies underline the effectiveness of FOP labels in guiding consumers' purchasing choices in hypothetical markets, there is a lack of studies conducted in real purchasing scenario (Temple, 2020). As stressed by Temple (2020), the effectiveness of the FOP labels in pushing consumers towards healthier food choices seems to decrease in real purchase situations. Specifically, from the literature analysis it emerged that MTL system was tested in UK (Sacks et al., 2009) and in Australia (Sacks et al., 2011) in real purchase context, showing no shift to healthier food choices, while the Guiding Stars system,

tested in USA in 2013, showed an increase in the healthier choice option of cereals about +1.5-2% (Rahkovsky et al., 2013). As recently found by Folkvord et al., (2021), these results does not surprise, considering that consumption behaviors is evolving over time and requires a more empirical and in depth understanding. Therefore, the effect of the FOP labels (and especially of the NS label) should be provided also in the real-purchasing context, thus proving the EU Commission with thorough and comprehensive results.

Against this context, it became clear why this research has been focused specifically on the NS label, assessing its effect on the internal market and estimating consumers' WTP for NS labelled products, especially within the Italian context (see Figure 1.1. for more details).

2.2. The Nutri-Score case

2.2.1. Into the NS system

The Nutri-Score is a summuray FOP nutrition label based on a graded color-coding system. As described in Figure 2.2., it combines colours and letters within a 5-points nutritional scale, ranging from dark green (letter A) to dark orange (letter E), to enhance the nutritional quality of the products (Julia & Hercberg, 2017a). As a FOP label, the Nutri-Score label has two specific objectives. The first one is to provide consumers with summarized nutritional information in a clear and easy-to-understand way, guiding them towards healthier food choices (Talati et al., 2017). The second one appeals to the competition among brands, encouraging the food industry to reformulate their products by improving their nutritional quality, and making them more attractive to consumers (Vyth et al., 2010).

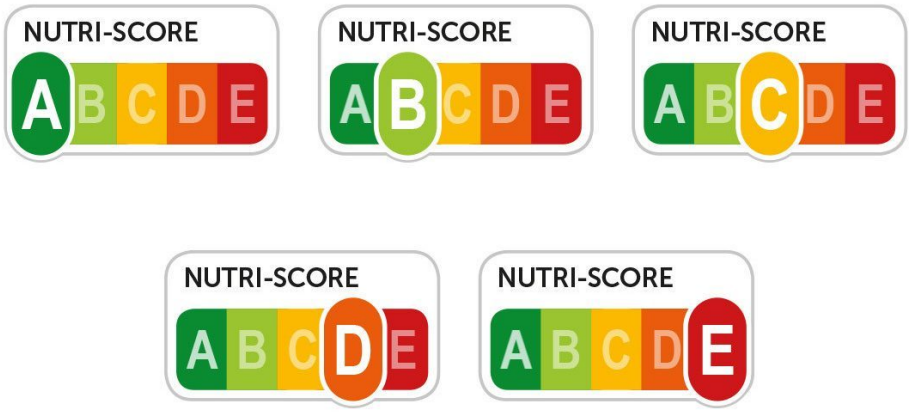

Figure 2.2. Graphic format of the NS label

As reported by Hercberg et al. (2021), the huge support of the NS label at the scientific level roots on its strong scientific basis, being its development incorporating a large amount of previous nutritional scientific work. To illustrate, its combination of colours and letters – initially developed by the UK Food Standard Agency (FSA) to set the rules for regulating food avertisments on TV (Rayner et al., 2009) – significantly help consumers in discriminate foods based on their healthiness, as widely stressed in lietrature (Borgmeier & Westenhoefer, 2009; Kelly et al., 2009; Nagle & Osorio, 1993). The NS algorithm, improved in its initial version proposed by the FSA following experts' suggestions (see for instance Braesco et al., 2022; Kissock et al., 2022), considers the nutritional value of 100 g of a given food (or beverage). Specifically, it allocates positive points (0–10) for nutrients/elements to be limited in consumption, as energy (kJ), total sugar (g), saturated fatty acids (g) and sodium (mg) content. Negative points (0–5) are given instead for nutrients/elements to be foster, as fruit, vegetables and nuts, olive oil and rapeseed oil, fibre, and protein content. The final score is based on a discrete continuous scale, ranging from −15 (most healthy) to +40 (least healthy) (Julia & Hercberg, 2017a).

2.2.2. Validation of the NS label: stressing its positive aspects

To test the effectiveness of the FOP nutrition labels, it became crucial to assess both the relevance of its algorithm and the efficacy of its visual design, as reported by Hercberg et al. (2022). To facilitate this assessment, a conceptual framework has been published by Hercberg et al. (2022), based on the scientific literature (Grunert & Wills, 2007; Townsend, 2010) and on the comprehensive process documented by WHO (2019, 2020b). This document delineates the validation studies necessary for the evaluation and selection of a front-of-pack nutrition label, as described in Figure 2.3.

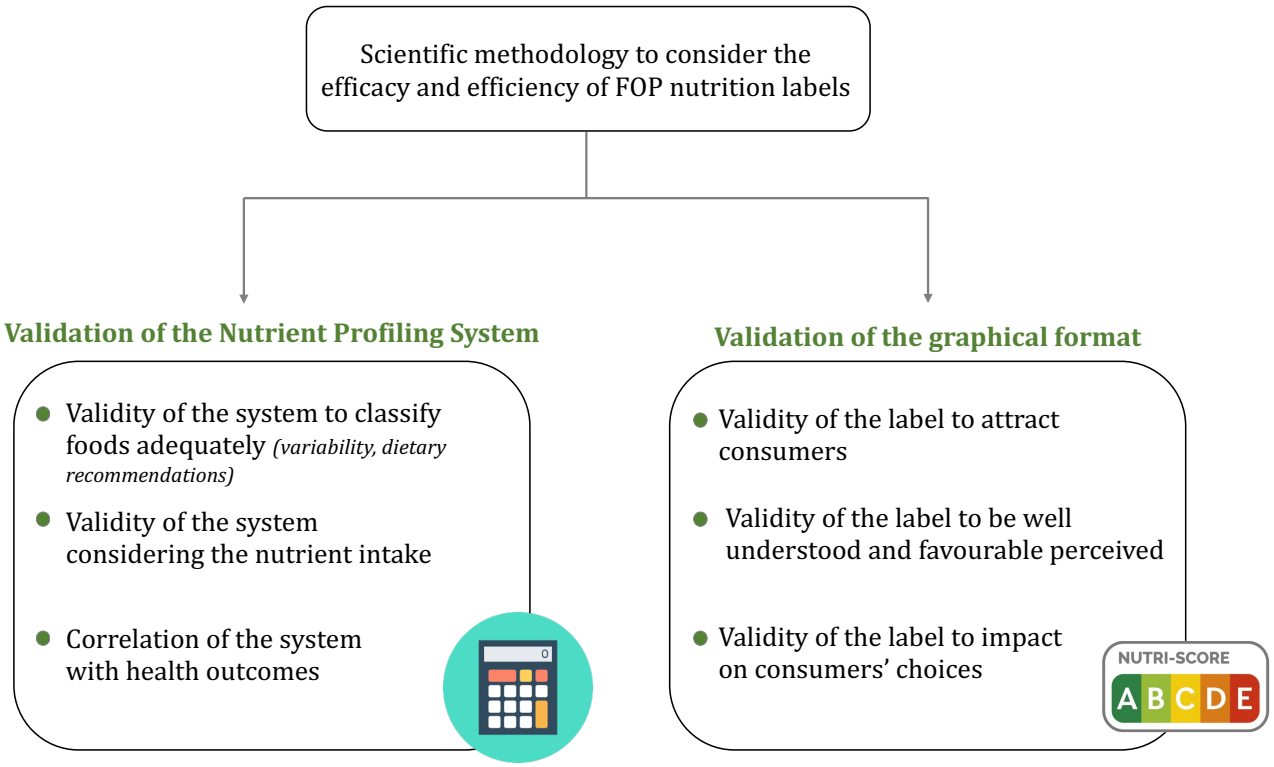

Figure 2.3. Conceptual scheme highlighting the validation studies required to select a nutrition FOP label (adapted from Hercberg et al., 2020)

According to this scheme, the NS has found to classify adequately foods, considering that most of products rich in fruits and vegetables generally reach a positive NS (NS=A or NS=B), while those with high level of sugar, salt, or fatty acid are classified as "unhealthy" products, with NS=D or NS=E, in line with dietary recommendations (Hercberg et al., 2022). Also, considering the nutrient intake and the biomarkers of nutritional status of the individuals, it is possible to catch the ability of the NS in promoting a healthier lifestyle. Different studies have been conducted to validate this aspect (Deschamps et al., 2015; Julia et al., 2015), reporting that individuals with dietary habits in line with the NS precepts generally consume more fruits/vegetables and fibers, with consequently high intake of vitamins (Julia et al., 2016). On the contrary, they generally consume less sweets and fatty products. Different studies have been conducted to highlights the correlation existing between the NS guidelines and the health-outcomes of the population. Individuals which follow a diet rich in foods promoted by the NS system are found to have a lower risk of developing chronic diseases, as cancer, cardiovascular diseases, or weight gain (Adriouch et al., 2017; Deschasaux et al., 2017).

When considering the validation of the graphical format of the NS, results underlined the "superiority of the NS compared to the other nutritional labels tested", as stated by Hercberg et

al. (2022), being the preferred format over others FOPLs. Indeed, different studies have been conducted within the EU context (see for instance Egnell et al., 2018), stressing the effectiveness of the NS in improving consumers' ability to classify products according to their nutritional profile. When evaluating the validity of the NS in guiding consumers' choices, several studies have outline the effectiveness of this label in improving the overall nutritional quality of consumers' shopping baskets (Hercberg et al., 2022). To illustrate, Egnell et al. (2021) tested respondents purchasing intentions in virtual supermarkets, Crosetto et al. (2017) evaluate the effectiveness of the label on real purchases in an experimental store study, and Dubois et al. (2020) tested the effect of different FOPLs in real scenario.

2.2.3. The dark side of the NS

Despite all these strengths of the NS, widely supported by scientific literature, the European Commission has not yet expressed its opinion in favor of this FOPL as the mandatory nutrition label to be used within the EU context, due to some opposition at the political and scientific level (Stiletto et al., 2023). Analyzing the scientific papers dealing with the NS topic, a heterogenous and unbalanced geographical distribution of publications emerged. Indeed, by analyzing the geographical attribution of the papers published until January 2023 on the NS topic, it emerged that more than 20.0% are published in France, while Spain (10.9%), Italy (7.0%), and Germany (3.9%) are significantly less prolific countries (Stiletto et al., 2023). These results are not surprising, since France is the country where NS was first adopted (Julia et al., 2017), Spain (2021) and Germany (2019) recently chose the NS as the voluntary FOP to use on their internal food markets, while Italy is actively contrasting its adoption at the EU level (Fialon et al., 2022). However, this polarization of publications could represent a hurdle for the EU adoption of NS. Focusing only on the aspects related to the NS that are more interesting for the pro-NS countries could generate a bias in the scientific results elaboration. Besides, being French (or Spanish/German) consumers more familiar with this label, the effectiveness of NS may be overestimated. Indeed, in countries where consumers are less used to this labeling system, the NS may partially loose its effectiveness (Santos et al., 2020), at least in the initial phases following its adoption, leading to delays in reaching the F2F goals.

Along with this aspect, the NS suffers from a lack of harmonization in describing products according to their NS level, as described in Chapter 5. Hercberg et al. (2022), in their

seminal work, reported that the NS "is not intended to characterize foods as "healthy" or "unhealthy" as a binary labelling scheme would", but aims to provide consumers with information about the nutritional profile of different foods, facilitating comparison within products. Also, the authors stressed that NS should not promote foods with positive NS rank just because they are "healthy", but should "emphasize that these products are preferable over their lower-ranked Nutri-Score alternatives that might be "competing" for purchase or consumption". However, the same authors previously defined products with positive NS (NS=A; NS=B) as foods with "higher quality" or "healthier", just as other authors (see for instance: Dréano-Trécant et al., 2020; Katsouri et al., 2021; Romero Ferreiro et al., 2021; Ter Borg et al., 2021). Other scholars identified, instead, products with positive NS label as foods with "high nutritional value" or "nutritionally valid products" and those with negative NS (NS=D; NS=E) as "nutritionally invalid products" or goods with "poor nutritional quality" (Blasco & Jiménez-Morales, 2021; Forner et al., 2021; Hafner & Pravst, 2021; Jiménez-Morales & Montaña Blasco, 2021), while only few paper used the terms "to be avoid in consumption" when products have low scores, as Blasco & Jiménez-Morales (2021) or Valenzuela et al. (2022). This lack of harmonization by the scientific community, combined with the lack of communication campaigns towards NS at a European level, creates an aura of uncertainty around this label, with a consequent misunderstanding in some consumers' segments, especially in countries where consumers are less familiar with the label.

Also, the NS aims to facilitate comparison within food category or substitute foods belonging to different categories (as in the case of different fats for cooking or dressing), along with food items proposed by different brands (Hercberg et al., 2022). Nevertheless, there are some food categories with low internal variability in terms of NS ranking, which complicates the evaluation for consumers. It is the case of animal origin products, with cheese and/or salami being the most representative examples. Yet, if in the initial version of the NS all cheeses were classified as products to be limited in consumption (NS=E), due to slight adjustments to the algorithm, the cheese evaluation range now goes from NS=C (e.g., mozzarella) to NS=E (e.g., hard cheese). The difference in evaluation between these two cheeses lies in the contents of macronutrients, such as fats and proteins, as well as the calorie or salt content of the products. On the contrary, micronutrients are not considered in the calculation, although NS supporters deem that the protein score is a good proxy for the content of some micronutrients, such as calcium in cheeses (Hercberg et al., 2022). Nonetheless, scientific articles with more technical slant state that hard cheeses (such as Parmigiano Reggiano or others) have a better nutritional

profile than fresh cheeses, if considering, for example, the content of zinc, an essential mineral which plays a key role in several important biological processes in the human body (Manzi et al., 2021). Also, being NS tailored on 100 g, it does not consider the typical portion size of products consumed, which has a large variability, especially considering cheeses. To illustrate, hard cheeses (as Parmigiano Reggiano PDO, Grana Padano PDO or other conventional seasoned cheese), blue cheese (as Camembert), or Feta cheese are generally consumed in much smaller quantities, being usually eat in addition to other dishes, as salads or pasta. It follows that, if the customary serving size is considered, the actual amount of nutrients is considerably less than what is implied by the conversion per 100 g/mL of product (Włodarek & Dobrowolski, 2022).

Most of these inconsistencies in the NS calculation system particularly affect GI products, as deeply detailed in the following section. Indeed, GIs are largely represented by products of animal origin (even if the main share of GIs is represented by Fruit and Vegetables) and cannot be easily reformulated to improve their level of NS. Moreover, recent research (Höhn et al., 2023) stressed that GIs are generally less likely to contain food additives and to be ultra-processed, being therefore more natural.

2.2.4. Health vs Tradition: the impact of NS on GIs

GIs are "indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin", as stressed by article 22 of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS). According to this definition, Geographical Indication does not just communicate the production site of a given product, but it also suggests that this production area confers a superior quality to the product, which is often a combination of natural properties of the territory and human factors (as the local know-how), generally described as "terroir". Such factors are usually recognized as credence attributes (Darby & Karni, 1973), as consumers are unable to verify these product' cues either before or after consumption. This condition leaves room for information asymmetry, with producers gaining economic advantages over consumers. GI, acting as a quality assurance, can solve this problem, protecting at the same time also producers. As stressed by Cei et al. (2018), GIs, being club goods and collective monopolies, can emphasize

the exclusion mechanism acting towards the producers located outside the geographical area protected by indication, thus assuring local actors a better rent because of perfect competition.

Within the EU context, regulation 1151/2012 protects GIs with two major origin labels: Protected Designations of Origin (PDOs) and Protected Geographical Indications (PGIs). In the first case, all production processes must be held in a denominated region, while for PGI only the most defining production steps must take place in the area defined. More in-depth, Regulation 1151/2012 stressed that the quality of PDO products is "essentially or exclusively due to a particular geographical environment with its inherent natural and human factors", while PGI "is a name which identifies a product whose given quality, reputation or other characteristic is essentially attributable to its geographical origin". Based on their capacity to convey quality and their focus on sustaining a competitive market environment, PDOs and PGIs aim to reach different objectives. These objectives encompass providing reliable information to consumers, safeguarding the diverse traditional and cultural heritage of the EU, and enhancing the value of traditional agricultural products, thereby boosting the income of producers (Poetschki et al., 2021). With particular emphasis on the latter function, the EU also expected a positive impact on rural development, which is particularly important in marginalized and less favored areas. Here, GIs can play a pivotal role in bridging the economic gap with wealthier regions (S. Zhang et al., 2023).

The European Commission, within F2F strategy, aims to reinforce GIs, considered as a tool to make the food system more robust and resilient. At the same time, the F2F stressed the need to promote healthier diets as a key-factor in guiding the transition towards a more sustainable food system through the adoption of the NS at the EU level. In this context, (part of) GIs could double meet the requirements set by the EU Commission, being a healthy choice for consumers, and supporting, at the same time, local economies (FAO, 2021; Vandecandelaere et al., 2021). Indeed, a large share of GIs is represented by fruit and vegetable products (28%), followed by cheeses (17.1%) and meat products, both processed (12.8%) or fresh (11.9%). However, as stressed by Höhn et al. (2023), literature lack in analyzing the role of the whole GI sector in boosting F2F goals. Indeed, as previously stressed, GIs of animal origin could be negatively rank by the NS label because of their nutritional profile. It goes without saying that these two labels (i.e., GI and NS) indicate different product characteristics, and that high-quality foods do not necessarily need to be healthy food, even if resent research found that PDO products are, in general, healthier than their convention counterparts (Höhn et al., 2023). However, even if apparently not conflicting, the presence of contradictory information on the

pack of the product could mislead consumers, as well as represent an economic damage for the GI sector. In fact, what seems to be in contrast is the effect that the two labels have on consumer preferences and, consequently, on the market. GIs are promoted and protected on the one hand by the GI policy (and also by the F2F strategy), with the aim of promoting the sales of these products to support the income of farmers, especially in rural areas, and are penalized by F2F (at least considering the requirement of a mandatory nutrition FOP to be used), with a disincentive in purchasing these products.

If not adequately understood, the presence of dark orange or red NS grades could potentially incentivize consumers to avoid these products, not just to reduce their consumption, as suggested by the F2F strategy. Also, the NS should not only guide consumers' choices but motivate, at the same time, producers to offer healthier options, through the reformulation of their products. Notably, major supermarket chains in Belgium have dedicated websites to "products with an improved Nutri-Score" (Delhaize, 2022). Therefore, GIs have to face a double challenge if their conventional counterparts within the same category (e.g., hams) offering superior NS grades. For instance, in France, many non-GI hams are marketed as "low-fat" or "low-salt" alternatives, targeted at health-conscious consumers. Such reformulations may be relatively straightforward for non-GI producers but might present challenges for GIs, bounded by stringent regulations (Höhn et al., 2023).

This aspect not only sheds some lights on the contradiction existing in the EU policies panorama, but also suggests the need for appropriate communication about how best to use the NS and avoid misunderstanding, as stressed by Hercberg et al. (2022). Indeed, any adoption of the NS label should be accompanied by a robust communication plan that transparently presents the evidence supporting its impact and efficacy. This crucial information needs to be disseminated not only by nutrition experts and healthcare professionals, but also through innovative channels like social media influencers. These unconventional strategies may be better suited to reach broader segments of the population (Hercberg et al., 2022).

To summarize, tha lack in literature adressing the potential negative effect of the NS label on GIs, largely discussed at political and public level, has encourage this research. Firstly, this work esplores the NS panoramas in Europe, highlithing the scientific research gap in facing the NS adoption (Chpater 3). Then, to assess Italian consumers' preferences towards NS labelled products, especially considering GIs, two different methodologies have been applied: a DCE (Chapter 4) and an EA (Chapter 5), performed before and after the information treatment. Finally, to estimate the effect of this label on real market, a hedonic price analysis has been

conducted on the French retail market, highlighting how Italian GIs are actually penalized in terms of retail price by the presence of the NS (Chapter 6).

This evidence is reported in the following papers, which is the result of this 3-years research:

1. Stiletto, A., Cei, L., & Trestini, S. (2023). A Little Bird Told Me… Nutri-Score Panoramas from a Flight over Europe, Connecting Science and Society. *Nutrients*, 15(15), 3367.
2. Stiletto, A., & Trestini, S. (2022). Is it really a piece of cake to label Geographical Indications with the Nutri-Score? Consumers' behaviour and policy implications. *Plos one*, 17(11), e0277048.
3. Stiletto, A., Vecchio, R., Cembalo, L., Trestini, S. Nutri-Score: checkmate to Geographical Indications? Evidence from an experimental auction in Italy. (In preparation for Appetite)
4. Stiletto, A., Cembalo, L., Trestini, S. All that glitters is not gold: The impact of the Nutri-Score label on food with Geographical Indication. (Submitted to Agricultural and Food Economics).

References

Adriouch, S., Julia, C., Kesse-Guyot, E., Ducrot, P., Péneau, S., Méjean, C., Assmann, K. E., Deschasaux, M., Hercberg, S., Touvier, M., & Fezeu, L. K. (2017). Association between a dietary quality index based on the food standard agency nutrient profiling system and cardiovascular disease risk among French adults. *International Journal of Cardiology*, *234*, 22–27. https://doi.org/10.1016/j.ijcard.2017.02.092

Ahn, C., & Lee, C. G. (2022). Effect of NUTRI-SCORE labeling on sales of food items in stores at sports and non-sports facilities. *Preventive Medicine Reports*, *29*(February), 101919. https://doi.org/10.1016/j.pmedr.2022.101919

Altamore, L., Ingrassia, M., Columba, P., Chironi, S., & Bacarella, S. (2020). Italian Consumers' Preferences for Pasta and Consumption Trends: Tradition or Innovation? *Journal of International Food and Agribusiness Marketing*, *32*(4), 337–360. https://doi.org/10.1080/08974438.2019.1650865

Ares, G., Varela, F., Machin, L., Antúnez, L., Giménez, A., Curutchet, M. R., & Aschemann-Witzel, J. (2018). Comparative performance of three interpretative front-of-pack nutrition labelling schemes: Insights for policy making. *Food Quality and Preference*, *68*, 215–225. https://doi.org/10.1016/J.FOODQUAL.2018.03.007

Arfini, F. (1999). The value of typical products: the case of Prosciutto di Parma and Parmigiano Reggiano cheese. *The Socio-Economics of Origin Labelled Products: Spatial, Institutional and Co-Ordination Aspects*, 78–97. http://ageconsearch.umn.edu/record/241032/files/Arfini _1999_ The value of typical products.pdf

Arfini, F., Boccaletti, S., Giacomini, C., Moro, D., & Sckokai, P. (2006). Case studies: Parmigiano Reggiano. *DG JRC/IPTS*.

Ballarini, G. (2022). Italiani consumatori di formaggio. *Ruminantia*.

Becker, G. M., DeGroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Experiments in Environmental Economics*, *9*(1964), 226–232.

Benfatto, L. (2021). Piadina protagonista sulla tavola: crescita record per le aziende del settore. *Ilsole24ore*.

Bilal, M., & Oxentenko, A. S. (2020). The Impact of Twitter: Why Should You Get Involved, and Tips and Tricks to Get Started. *American Journal of Gastroenterology*, *115*(10), 1549–1552. https://doi.org/10.14309/ajg.0000000000000763

Blasco, M. M., & Jiménez-Morales, M. (2021). Breakfast food advertising and prevention of obesity: Analysis of the nutritional value of the products and discursive strategies used in the breakfast ads from 2015 to 2019. *Nutrients*, *13*(1), 1–9. https://doi.org/10.3390/nu13010231

Borgmeier, I., & Westenhoefer, J. (2009). *Impact of different food label formats on healthiness evaluation and food choice of consumers: a randomized-controlled study*. https://doi.org/10.1186/1471-2458-9-184

Bostic, S. M., & McClain, A. C. (2017). Older adults' cooking trajectories: shifting skills and strategies. *British Food Journal*, *119*(5), 1102–1115. https://doi.org/10.1108/BFJ-09-2016-0436

Boztuğ, Y., Juhl, H. J., Elshiewy, O., & Jensen, M. B. (2015). Consumer response to monochrome Guideline Daily Amount nutrition labels. *Food Policy*, *53*, 1–8. https://doi.org/10.1016/j.foodpol.2015.03.002

Braesco, V., Ros, E., Govindji, A., Bianchi, C., Becqueriaux, L., & Quick, B. (2022). A Slight Adjustment of the Nutri-Score Nutrient Profiling System Could Help to Better Reflect the European Dietary Guidelines Regarding Nuts. *Nutrients*, *14*(13). https://doi.org/10.3390/nu14132668

Braveman, P. A., Cubbin, C., Egerter, S., Chideya, S., Marchi, K. S., Metzler, M., & Posner, S. (2005). Socioeconomic Status in Health Research. *Jama*, *294*(22), 2879. https://doi.org/10.1001/jama.294.22.2879

Bronnmann, J., & Hoffmann, J. (2018). Product differentiation in the German soft drink market: which attributes matter? *Applied Economics Letters*, *25*(14), 968–971. https://doi.org/10.1080/13504851.2017.1388906

Cameron, A., & Trivedi, P. (2005). *Microeconometrics: Methods and Applications*. https://doi.org/10.1017/CBO9780511811241

Campos, S., Doxey, J., & Hammond, D. (2011). Nutrition labels on pre-packaged foods: A systematic review. In *Public Health Nutrition* (Vol. 14, Issue 8, pp. 1496–1506). https://doi.org/10.1017/S1368980010003290

Capacci, S., Mazzocchi, M., Shankar, B., Macias, B., Verbeke, W., Ja Pérez-Cueto, F., Kozioł-Kozakowska, A., Piórecka, B., Niedzwiedzka, B., D'addesa, D., Saba, A., Turrini, A., Aschemann-Witzel, J., Bech-Larsen, T., Strand, M., Smillie, L., Wills, J., & Traill, B. (2012). Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness. *Nutrition Reviews*, *70*(3), 188–200. https://doi.org/10.1111/j.1753-4887.2011.00442.x

Caracciolo, F., Cembalo, L., & Pomarici, E. (2013). The hedonic price for an Italian grape variety. *Italian Journal of Food Science*, *25*(3). https://flore.unifi.it/retrieve/handle/2158/820872/26648/IJFS253.rar#page=42

Carlucci, D., De Gennaro, B., Roselli, L., & Seccia, A. (2014). E-commerce retail of extra virgin olive oil: An hedonic analysis of Italian Smes supply. *British Food Journal*, *116*(10), 1600–1617. https://doi.org/10.1108/BFJ-05-2013-0138

Carruba, M. O., Caretto, A., De Lorenzo, A., Fatati, G., Ghiselli, A., Lucchin, L., Maffeis, C., Malavazos, A., Malfi, G., Riva, E., Ruocco, C., Santini, F., Silano, M., Valerio, A., Vania, A., & Nisoli, E. (2022). *Front-of-pack (FOP) labelling systems to improve the quality of nutrition information to prevent obesity: NutrInform Battery vs Nutri-Score*. *27*, 1575–1584. https://doi.org/10.1007/s40519-021-01316-z

Carter, O., Mills, B. W., Lloyd, E., & Phan, T. (2013). An independent audit of the Australian food industry's voluntary front-of-pack nutrition labelling scheme for energy-dense nutrition-poor foods. *European Journal of Clinical Nutrition*, *67*, 31–35. https://doi.org/10.1038/ejcn.2012.179

Caso, G., & Vecchio, R. (2022). Factors influencing independent older adults (un)healthy food choices: A systematic review and research agenda. *Food Research International*, *158*(February), 111476. https://doi.org/10.1016/j.foodres.2022.111476

Cavallo, C., Caracciolo, F., Cicia, G., & Del Giudice, T. (2018). Extra-virgin olive oil: are consumers provided with the sensory quality they want? A hedonic price model with sensory attributes. *Journal of the Science of Food and Agriculture*, *98*(4), 1591–1598. https://doi.org/10.1002/JSFA.8633

Cawley, J., Sweeney, M. J., Sobal, J., Just, D. R., Kaiser, H. M., Schulze, W. D., Wethington, E., & Wansink, B. (2015). The impact of a supermarket nutrition rating system on purchases of nutritious and less nutritious foods. *Public Health Nutrition*, *18*(1), 8–14. https://doi.org/10.1017/S1368980014001529

Cei, L., Defrancesco, E., & Stefani, G. (2018). From geographical indications to rural development: A review of the economic effects of European Union policy. *Sustainability (Switzerland)*, *10*(10). https://doi.org/10.3390/su10103745

Chang, J. B., Lusk, J. L., & Norwood, B. F. (2009). How closely do hypothetical surveys and laboratory experiments predict field behavior? *American Journal of Agricultural Economics*, *91*(2), 518–534. https://doi.org/10.1111/j.1467-8276.2008.01242.x

Chantal, J., Touvier, M., Kesse-Guyot, E., Galan, P., & Hercberg, S. (2022). Nutri-Score in tug-of-war between public health and economic interests in the European Union. *Nature Food*, *3*(181).

Cirera, X., & Masset, E. (2010). Income distribution trends and future food demand. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2821–2834. https://doi.org/10.1098/rstb.2010.0164

Combris, P., Lecocq, S., & Visser, M. (1997). Estimation of a Hedonic Price Equation for Bordeaux Wine: Does Quality Matter? *The Economic Journal*, *107*(441), 390–402. https://doi.org/10.1111/j.0013-0133.1997.165.x

Commission, E. (2021). *Study on economic value of EU quality schemes, geographical indications (GIs) and traditional specialities guaranteed (TSGs) : final report*. Publications Office. https://doi.org/doi/10.2762/396490

Costanigro, M., McCluskey, J. J., & Mittelhammer, R. C. (2007). Segmenting the Wine Market Based on Price: Hedonic Regression when Different Prices mean Different Products. *Journal of Agricultural Economics*, *58*(3), 454–466. https://doi.org/10.1111/j.1477-9552.2007.00118.x

Cowburn, G., & Stockley, L. (2005). Consumer understanding and use of nutrition labelling: a systematic review. *Public Health Nutrition*, *8*(1), 21–28. https://doi.org/10.1079/phn2005666

Cozzi, E., Donati, M., Mancini, M. C., Guareschi, M., & Veneziani, M. (2019). PDO parmigiano reggiano cheese in Italy. *Sustainability of European Food Quality Schemes: Multi-Performance, Structure, and Governance of PDO, PGI, and Organic Agri-Food Systems*, 427–449. https://doi.org/10.1007/978-3-030-27508-2_22

Crescenzi, R., De Filippis, F., Giua, M., & Vaquero-Piñeiro, C. (2022). Geographical Indications and local development: the strength of territorial embeddedness. *Regional Studies*, *56*(3), 381–393. https://doi.org/10.1080/00343404.2021.1946499

Crosetto, P., Lacroix, A., Muller, L., & Ruffieux, B. (2017). Modifications of food purchases in response to five nutrition simplified labelling. *Cahiers de Nutrition et de Dietetique*, *52*(3), 129–133. https://doi.org/10.1016/j.cnd.2017.04.002

Darby, M. R., & Karni, E. (1973). Free competition and the optimal amount of fraud. *The Journal of Law and Economics*, *16*(1), 67–88.

Darmon, N., & Drewnowski, A. (2008). Does social class predict diet quality? *American Journal of Clinical Nutrition*, *87*(5), 1107–1117. https://doi.org/10.1093/ajcn/87.5.1107

De Bauw, M., De La Revilla, L. S., Poppe, V., Matthys, C., & Vranken, L. (2022). Digital nudges to

stimulate healthy and pro-environmental food choices in E-groceries. *Appetite*, *172*(July 2021), 105971. https://doi.org/10.1016/j.appet.2022.105971

De Bauw, M., Matthys, C., Poppe, V., Franssens, S., & Vranken, L. (2021a). A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. *Food Quality and Preference*, *93*(April), 104276. https://doi.org/10.1016/j.foodqual.2021.104276

De Bauw, M., Matthys, C., Poppe, V., Franssens, S., & Vranken, L. (2021b). A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. *Food Quality and Preference*, *93*, 104276. https://doi.org/10.1016/J.FOODQUAL.2021.104276

De Temmerman, J., Heeremans, E., Slabbinck, H., & Vermeir, I. (2021). The impact of the Nutri-Score nutrition label on perceived healthiness and purchase intentions. *Appetite*, *157*, 104995. https://doi.org/10.1016/J.APPET.2020.104995

Delamaire, C., Bossard, C., & Julia, C. (2008). Perceptions, connaissances et attitudes en matière d'alimentation. In *Baromètre santé nutrition 2008* (pp. 80–116).

Delhaize. (2022). *Producten met een verbeterde Nutri-Score*. https://www.delhaize.be/nl/nutriscore-update, accessed 28 July 2022

Deschamps, V., Julia, C., Salanave, B., Verdot, C., Hercberg, S., & Castetbon, K. (2015). Score de qualité nutritionnelle des aliments dela Food Standards Agency appliqué aux consommationsalimentaires individuelles des adultes en France. *Bulletin Epidémiologique Hebdomadaire*, 466–475.

Deschasaux, M., Julia, C., Kesse-Guyot, E., Lécuyer, L., Adriouch, S., Méjean, C., Ducrot, P., Péneau, S., Latino-Martel, P., Fezeu, L. K., Fassier, P., Hercberg, S., & Touvier, M. (2017). Are self-reported unhealthy food choices associated with an increased risk of breast cancer? Prospective cohort study using the British Food Standards Agency nutrient profiling system. *BMJ Open*, *7*(6). https://doi.org/10.1136/bmjopen-2016-013718

Deselnicu, O. C., Costanigro, M., Souza-Monteiro, D. M., & McFadden, D. T. (2013). A Meta-Analysis of Geographical Indication Food Valuation Studies: What Drives the Premium for Origin-Based Labels? *Journal of Agricultural and Resource Economics*, *2*, 204–219.

Di Vita, G., Caracciolo, F., Cembalo, L., Pomarici, E., & D'Amico, M. (2015). Drinking wine at home: Hedonic analysis of sicilian wines using quantile regression. *American Journal of Applied Sciences*, *12*(10), 679–688. https://doi.org/10.3844/ajassp.2015.679.688

Djuricic, I., & Calder, P. C. (2021). Beneficial outcomes of omega-6 and omega-3 polyunsaturated fatty acids on human health: An update for 2021. *Nutrients*, *13*(7). https://doi.org/10.3390/nu13072421

Dobbs, R., & Manyika, J. (2015). The Obesity Crisis. *The Cairo Review of Global Affairs*, 44–57. https://doi.org/10.1159/000355993

Dowler, E. (2001). Inequalities in diet and physical activity in Europe. *Public Health Nutrition*, *4*(2b), 701–709. https://doi.org/10.1079/phn2001160

Dréano-Trécant, L., Egnell, M., Hercberg, S., Galan, P., Soudon, J., Fialon, M., Touvier, M., Kesse-Guyot, E., & Julia, C. (2020). Performance of the front-of-pack nutrition label nutri-score to discriminate the nutritional quality of foods products: A comparative study across 8 european countries. *Nutrients*,

12(5). https://doi.org/10.3390/nu12051303

Dubois, P., Albuquerque, P., Allais, O., Bonnet, C., Bertail, P., Combris, P., Lahlou, S., Rigal, N., Ruffieux, B., & Chandon, P. (2020). Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: evidence from a large-scale randomized controlled trial. *Journal of the Academy of Marketing Science*. https://doi.org/10.1007/s11747-020-00723-5

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L., Hercberg, S., & Péneau, S. (2015a). Effectiveness of Front-Of-Pack Nutrition Labels in French Adults: Results from the NutriNet-Santé Cohort Study. *PLoS One, 10*(10). https://doi.org/10.1371/journal.pone.0140898

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L. K., Hercberg, S., & Péneau, S. (2015b). Objective Understanding of Front-of-Package Nutrition Labels among Nutritionally At-Risk Individuals. *Nutrients*, *7*, 7106–7125. https://doi.org/10.3390/nu7085325

Edenbrandt, A. K., Smed, S., & Jansen, L. (2018). A hedonic analysis of nutrition labels across product types and countries. *European Review of Agricultural Economics*, *45*(1), 101–120. https://doi.org/10.1093/erae/jbx025

Egnell, M., Ducrot, P., Touvier, M., Allès, B., Hercberg, S., Kesse-Guyot, E., & Julia, C. (2018). Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: Comparisons with other format labels. *PLoS ONE*, *13*(8). https://doi.org/10.1371/journal.pone.0202095

Egnell, M., Galan, P., Fialon, M., Touvier, M., Péneau, S., Kesse-Guyot, E., Hercberg, S., & Julia, C. (2021). The impact of the Nutri-Score front-of-pack nutrition label on purchasing intentions of unprocessed and processed foods: post-hoc analyses from three randomized controlled trials. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 1–12. https://doi.org/10.1186/s12966-021-01108-9

Elizabeth, L., Machado, P., Zinöcker, M., Baker, P., & Lawrence, M. (2020). Ultra-processed food and adverse health outcomes. *Nutrients*, *12*(7). https://doi.org/10.1136/bmj.l2289

European Commission. (2020a). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system*.

European Commission. (2020b). *Geographical Indications - a Europeam tresure worth €75 billion*.

FAO. (2021). *The Nutrition and Health Potential of Geographical Indication Foods*.

Fedoseeva, S. (2020). (Dynamic) willingness to pay and e-commerce: Insights from sparkling wine sector in Russia. *Journal of Retailing and Consumer Services*, *57*, 102180. https://doi.org/10.1016/J.JRETCONSER.2020.102180

Fialon, M, Salas-Salvadó, J., Babio, N., Touvier, M., Hercberg, S., & Galan, P. (2021). Is fop nutrition label nutri-score well understood by consumers when comparing the nutritional quality of added fats, and does it negatively impact the image of olive oil? *Foods*, *10*(9). https://doi.org/10.3390/foods10092209

Fialon, Morgane, Egnell, M., Talati, Z., Galan, P., Dréano-Trécant, L., Touvier, M., Pettigrew, S., Hercberg, S., & Julia, C. (2020). Effectiveness of different front-of-pack nutrition labels among italian consumers: Results from an online randomized controlled trial. *Nutrients*, *12*(8), 1–13. https://doi.org/10.3390/nu12082307

Fialon, Morgane, Serafini, M., Galan, P., Kesse-Guyot, E., Touvier, M., Deschasaux-Tanguy, M., Sarda, B., Hercberg, S., Nabec, L., & Julia, C. (2022). Nutri-Score and NutrInform Battery: Effects on Performance and Preference in Italian Consumers. *Nutrients*, *14*(17), 1–12. https://doi.org/10.3390/nu14173511

Folkvord, F., Bergmans, N., & Pabian, S. (2021). The effect of the nutri-score label on consumer's attitudes, taste perception and purchase intention: An experimental pilot study. *Food Quality and Preference*, *94*, 104303. https://doi.org/10.1016/j.foodqual.2021.104303

Forner, F., Volkhardt, I., Meier, T., Christen, O., & Stangl, G. I. (2021). The nutriRECIPE-Index – development and validation of a nutrient-weighted index for the evaluation of recipes. *BMC Nutrition*, *7*(1). https://doi.org/10.1186/s40795-021-00483-7

Fuchs, K. L., Lian, J., Michels, L., Mayer, S., Toniato, E., & Tiefenbeck, V. (2022). Effects of Digital Food Labels on Healthy Food Choices in Online Grocery Shopping. *Nutrients*, *14*(10), 2044. http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=84403754&site=ehost-live

Gassler, B., Faesel, C. K., & Moeser, A. (2022). Toward a differentiated understanding of the effect of Nutri-Score nutrition labeling on healthier food choices. *Agribusiness*, *39*(1), 28–50. https://doi.org/10.1002/AGR.21762

Glogoveţan, A. I., Dabija, D. C., Fiore, M., & Pocol, C. B. (2022). Consumer Perception and Understanding of European Union Quality Schemes: A Systematic Literature Review. *Sustainability (Switzerland)*, *14*(3), 1–16. https://doi.org/10.3390/su14031667

Graham, D. J., Lucas-Thompson, R. G., Mueller, M. P., Jaeb, M., & Harnack, L. (2017). Impact of explained v. unexplained front-of-package nutrition labels on parent and child food choices: A randomized trial. *Public Health Nutrition*, *20*(5), 774–785. https://doi.org/10.1017/S1368980016002676

Grunert, K. G., & Aachmann, K. (2016). Consumer reactions to the use of EU quality labels on food products: Areview of the literature. *Food Control*, *59*, 178–187. https://doi.org/10.1016/j.foodcont.2015.05.021

Grunert, K. G., Fernández-Celemín, L., Wills, J. M., Bonsmann, S. S. G., & Nureeva, L. (2010). Use and understanding of nutrition information on food labels in six European countries. *Journal of Public Health*, *18*(3), 261–277. https://doi.org/10.1007/s10389-009-0307-0

Grunert, K. G., & Wills, J. M. (2007). A review of European research on consumer response to nutrition information on food labels. *Journal of Public Health*, *15*(5), 385–399. https://doi.org/10.1007/s10389-007-0101-9

Habib, S. H., & Saha, S. (2010). Burden of non-communicable disease: Global overview. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *4*(1), 41–47. https://doi.org/10.1016/j.dsx.2008.04.005

Hafner, E., & Pravst, I. (2021). Evaluation of the Ability of Nutri-Score to Discriminate the Nutritional Quality of Prepacked Foods Using a Sale-Weighting Approach. *Foods*, *10*, 1689. https://doi.org/10.3390/foods10081689

Hall, K. D., Ayuketah, A., Brychta, R., Cai, H., Cassimatis, T., Chen, K. Y., Chung, S. T., Costa, E., Courville, A., Darcey, V., Fletcher, L. A., Forde, C. G., Gharib, A. M., Guo, J., Howard, R., Joseph, P. V., McGehee, S., Ouwerkerk, R., Raisinger, K., … Zhou, M. (2019). Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake. *Cell Metabolism*, *30*(1), 67-77.e3. https://doi.org/10.1016/j.cmet.2019.05.008

Hamlin, R. (2015). Front of Pack Nutrition Labelling, Nutrition, Quality and Consumer Choices. *Current Nutrition Reports*, *4*(4), 323–329. https://doi.org/10.1007/s13668-015-0147-1

Hawkes, C., & Popkin, B. M. (2015). Can the sustainable development goals reduce the burden of nutrition-related non-communicable diseases without truly addressing major food system reforms? *BMC Medicine*, *13*(1), 1–3. https://doi.org/10.1186/s12916-015-0383-7

Hercberg, S., Touvier, M., & Salas-salvado, J. (2022). The Nutri-Score nutrition label. *International Journal for Vitamin and Nutrition Research*, *92*(3–4), 147–157.

Hercberg, S., Touvier, M., & Salas-Salvado, J. (2021). The Nutri-Score nutrition label. *Https://Doi.Org/10.1024/0300-9831/A000722*, *92*(3–4), 147–157. https://doi.org/10.1024/0300-9831/A000722

Hillmann, H., & Hofmann, T. (2016). Quantitation of Key Tastants and Re-engineering the Taste of Parmesan Cheese. *Journal of Agricultural and Food Chemistry*, *64*(8), 1794–1805. https://doi.org/10.1021/acs.jafc.6b00112

Höhn, G. L., Huysmans, M., & Crombez, C. (2023). Healthy food traditions? Nutritional quality and food composition of EU geographical indications. *Q Open*, *3*(1), 1–20. https://doi.org/10.1093/qopen/qoad014

Holmes, T. P., Adamowicz, W. L., & Carlsson, F. (2017). Choice Experiments. In *A Primer on Nonmarket Valuation*.

Iotti, M., & Bonazzi, G. (2014). The application of Life Cycle Cost (LCC) approach to quality food production: A comparative analysis in the parma pdo ham sector. *American Journal of Applied Sciences*, *11*(9), 1492–1506. https://doi.org/10.3844/ajassp.2014.1492.1506

ISMEA. (2019). *Rapporto 2019 Ismea-Qualivita sulle produzioni agroalimentari e vitivinicole italiane DOP, IGP e STG*.

ISMEA. (2020). *Rapporto Ismea - Qualivita 2020*.

ISMEA. (2021). *RAPPORTO ISMEA - QUALIVITA 2021 sulle produzioni vitivinicole e agroalimentari DOP Italia*.

Jiménez-Morales, M., & Montaña Blasco, M. (2021). Presence and strategic use of the Mediterranean Diet in food marketing: Analysis and association of nutritional values and advertising claims from 2011 to 2020. *NFS Journal*, *24*(April), 1–6. https://doi.org/10.1016/j.nfs.2021.04.003

Journo, L. J., & Snipes, K. (2018). FRANCE RETAIL FOODS 2018. In *USDA Foreign Agricultural Service*.

Julia, C., Blanchet, O., Méjean, C., Péneau, S., Ducrot, P., Allès, B., Fezeu, L. K., Touvier, M., Kesse-Guyot, E., Singler, E., & Hercberg, S. (2016). Impact of the front-of-pack 5-colour nutrition label (5-CNL) on the nutritional quality of purchases: An experimental study. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1), 1–9. https://doi.org/10.1186/s12966-016-0416-4

Julia, C., Ducrot, P., Péneau, S., Deschamps, V., Méjean, C., Fézeu, L., Touvier, M., Hercberg, S., & Kesse-Guyot, E. (2015). Discriminating nutritional quality of foods using the 5-Color nutrition label in the French food market: Consistency with nutritional recommendations. *Nutrition Journal*, *14*(1), 1–12. https://doi.org/10.1186/s12937-015-0090-4

Julia, C., & Hercberg, S. (2016). Research and lobbying conflicting on the issue of a front-of-pack nutrition labelling in France. *Archives of Public Health*, *74*(1), 1–5.

https://doi.org/10.1186/s13690-016-0162-8

Julia, C., & Hercberg, S. (2017a). Development of a new front-of-pack nutrition label in France: the five-colour Nutri-Score. *Public Health Panorama*, *03*(04), 712–725.

Julia, C., & Hercberg, S. (2017b). Nutri-Score: evidence of the effective-ness of the French front-of-pack nutrition label. *Ernahrungs Umschau*, *64*(12), 181–187. https://doi.org/10.4455/eu.2017.048

Julia, C., Méjean, C., Touvier, M., Péneau, S., Lassale, C., Ducrot, P., Hercberg, S., & Kesse-Guyot, E. (2016). Validation of the FSA nutrient profiling system dietary index in French adults—findings from SUVIMAX study. *European Journal of Nutrition*, *55*(5), 1901–1910. https://doi.org/10.1007/s00394-015-1006-y

Julia, C., Péneau, S., Buscail, C., Gonzalez, R., Touvier, M., Hercberg, S., & Kesse-Guyot, E. (2017). Perception of different formats of front-of-pack nutrition labels according to sociodemographic, lifestyle and dietary factors in a French population: Cross-sectional study among the NutriNet-Santé cohort participants. *BMJ Open*, *7*(6). https://doi.org/10.1136/bmjopen-2017-016108

Katsouri, E., Magriplis, E., Zampelas, A., Drosinos, E. H., & Nychas, G.-J. (2021). Dietary intake assessment of pre-packed graviera cheese in greece and nutritional characterization using the nutri-score front of pack label scheme. *Nutrients*, *13*(2), 1–15. https://doi.org/10.3390/nu13020295

Kelly, B., Hughes, C., Chapman, K., Louie, J. C. Y., Dixon, H., Crawford, J., King, L., Daube, M., & Slevin, T. (2009). Consumer testing of the acceptability and effectiveness of front-of-pack food labelling systems for the Australian grocery market. *Health Promotion International*, *24*(2), 120–129. https://doi.org/10.1093/heapro/dap012

Kennedy, P. E. (1981). Estimation with correctly interpreted dummy variables in semilogarithmic equations. *The American Economic Review*, *71*(4), 801.

Kissock, K. R., Vieux, F., Mathias, K. C., Drewnowski, A., Seal, C. J., Masset, G., Smith, J., Mejborn, H., McKeown, N. M., & Beck, E. J. (2022). Aligning nutrient profiling with dietary guidelines: modifying the Nutri-Score algorithm to include whole grains. *European Journal of Nutrition*, *61*(1), 541–553. https://doi.org/10.1007/s00394-021-02718-6

Koppel, K., & Chambers, D. H. (2012). Flavor Comparison of Natural Cheeses Manufactured in Different Countries. *Journal of Food Science*, *77*(5), 177–187. https://doi.org/10.1111/j.1750-3841.2012.02674.x

Lancaster, K. J. (1966). A New Approach to Consumer Theory. *Current*, *74*(2), 132–157.

Leufkens, D. (2018). The problem of heterogeneity between protected geographical indications: A meta-analysis. *British Food Journal*, *120*, 2843–2856.

List, J. A., & Gallet, C. A. (2001). What Experimental Protocol Influence Disparities Between Actual and Hypothetical Stated Values? Evidence from a Meta-Analysis. In *Environmental and Resource Economics* (Vol. 20).

Lombardi, A., Vecchio, R., Borrello, M., Caracciolo, F., & Cembalo, L. (2019). Willingness to pay for insect-based food: The role of information and carrier. *Food Quality and Preference*, *72*(September 2018), 177–187. https://doi.org/10.1016/j.foodqual.2018.10.001

Lucas, R. E. B. (1975). HEDONIC PRICE FUNCTIONS. *Economic Inquiry*, *13*(2), 157–178. https://doi.org/10.1111/J.1465-7295.1975.TB00985.X

Lusk, J. L., Alexander, C., & Rousu, M. C. (2007). Designing experimental auctions for marketing research: The effect of values, distributions, and mechanisms on incentives for truthful bidding. *Review of Marketing Science*, *5*(February). https://doi.org/10.2202/1546-5616.1059

Lusk, J. L., & Shogren, J. F. (2007). Experimental Auctions: Methods and Applications in Economic and Marketing Research. In *Quantitative Methods for Applied Economics and Business Research* (p. 316). Cambridge University Press (CUP).

Lynch Jr, J. G. (1982). On the external validity of experiments in consumer research. *Journal of Consumer Research*, *9*(3), 225–239.

Manzi, P., Gabriella, M., Costanzo, D., & Ritota, M. (2021). Content and Nutritional Evaluation of Zinc in PDO and Traditional Italian Cheeses. *Molecules*, *26*(20), 6300.

Mazzù, M. F., Romani, S., & Gambicorti, A. (2020). Effects on consumers' subjective understanding of a new front-of-pack nutritional label: a study on Italian consumers. *Https://Doi.Org/10.1080/09637486.2020.1796932*, *72*(3), 357–366. https://doi.org/10.1080/09637486.2020.1796932

Mora-García, C. A., Tobar, L. F., & Young, J. C. (2019). The effect of randomly providing nutri-score information on actual purchases in Colombia. *Nutrients*, *11*(3). https://doi.org/10.3390/nu11030491

Nagle, M. G., & Osorio, T. D. (1993). The tuning of human photopigments may minimize red-green chromatic signals in natural conditions. *Proceedings of the Royal Society B: Biological Sciences*, *252*(1335), 209–213. https://doi.org/10.1098/rspb.1993.0067

Neal, B., Crino, M., Dunford, E., Gao, A., Greenland, R., Li, N., Ngai, J., Ni Mhurchu, C., Pettigrew, S., Sacks, G., Webster, J., & Y Wu, J. H. (2017). Effects of Different Types of Front-of-Pack Labelling Information on the Healthiness of Food Purchases-A Randomised Controlled Trial. *Nutrients*, *9*(12). https://doi.org/10.3390/nu9121284

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M. E., Achoki, T., Albuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., Guzman, N. A., … Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *384*(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8

Noussair, C., Robin, S., & Ruffieux, B. (2004). Revealing consumers' willingness-to-pay: A comparison of the BDM mechanism and the Vickrey auction. *Journal of Economic Psychology*, *25*(6), 725–741. https://doi.org/10.1016/J.JOEP.2003.06.004

Nseir, W., Nassar, F., & Assy, N. (2010). Soft drinks consumption and nonalcoholic fatty liver disease. *World Journal of Gastroenterology*, *16*(21), 2579–2588. https://doi.org/10.3748/wjg.v16.i21.2579

Oczkowski, E. (1994). A HEDONIC PRICE FUNCTION FOR AUSTRALIAN PREMIUM TABLE WINE*. *Australian Journal of Agricultural Economics*, *38*(1), 93–110. https://doi.org/10.1111/j.1467-8489.1994.tb00721.x

Onwezen, M. C., Reinders, M. J., Verain, M. C. D., & Snoek, H. M. (2019). The development of a single-item Food Choice Questionnaire. *Food Quality and Preference*, *71*(May 2018), 34–45. https://doi.org/10.1016/j.foodqual.2018.05.005

Pettigrew, S., Jongenelis, M. I., Jones, A., Hercberg, S., & Julia, C. (2023). An 18-country analysis of the effectiveness of five front-of-pack nutrition labels. *Food Quality and Preference*, *104*. https://doi.org/10.1016/J.FOODQUAL.2022.104691

Poetschki, K., Peerlings, J., & Dries, L. (2021). The impact of geographical indications on farm incomes in the EU olives and wine sector. *British Food Journal*, *123*(13), 579–598. https://doi.org/10.1108/BFJ-12-2020-1119

Poinsot, R., Vieux, F., Dubois, C., Perignon, M., Méjean, C., & Darmon, N. (2020). Nutritional quality of vegetarian and non-vegetarian dishes at school: Are nutrient profiling systems sufficiently informative? *Nutrients*, *12*(8), 1–17. https://doi.org/10.3390/nu12082256

Qualivita. (2022). *Cresce la filiera IGP della Pasta di Gragnano: produzione + 84% nell'ultimo triennio*. https://www.qualivita.it/news/cresce-la-filiera-igp-della-pasta-di-gragnano-produzione-84-nellultimo-triennio/

Rahkovsky, I., Lin, B. H., Lin, C. T. J., & Lee, J. Y. (2013). *Effects of the Guiding Stars Program on purchases of ready-to-eat cereals with different nutritional attributes*. Food Policy. https://doi.org/10.1016/j.foodpol.2013.08.013

Rayner, M., Scarborough, P., Heart, B., & Health, F. (2009). The UK Ofcom Nutrient Profiling Model. In *UK Ofcom*. https://www.ndph.ox.ac.uk

Resano-Ezcaray, H., & Sanjuàn-Lòpez, I. A. (2008). An hedonic approach applied to scanner data on cured ham purchases in Spain. *12th EAAE Congress 'People, Food and Environments: Global Trends and European Strategies.'* https://doi.org/10.22004/AG.ECON.44383

Resano-Ezcaray, H., Sanjuàn-Lòpez, I. A., & Albisu-Aguado, L. M. (2010). Combining Stated and Revealed Preferences on Typical Food Products: The Case of Dry-Cured Ham in Spain. *Journal of Agricultural Economics*, *61*(3), 480–498. https://doi.org/10.1111/j.1477-9552.2010.00250.x

Roheim, C. A., Asche, F., & Santos, J. I. (2011). The elusive price premium for ecolabelled products: Evidence from seafood in the UK market. *Journal of Agricultural Economics*, *62*(3), 655–668. https://doi.org/10.1111/j.1477-9552.2011.00299.x

Romero Ferreiro, C., Lora Pablos, D., & Gómez de la Cámara, A. (2021). Two dimensions of nutritional value: Nutri-score and nova. *Nutrients*, *13*(8). https://doi.org/10.3390/nu13082783

Rosen, S. (1974). *Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition*. http://www.journals.uchicago.edu/t-and-c

Sacks, G., Rayner, M., & Swinburn, B. (2009). Impact of front-of-pack "traffic-light" nutrition labelling on consumer food purchases in the UK. *Health Promotion International*, *24*(4), 344–352. https://doi.org/10.1093/heapro/dap032

Sacks, G., Tikellis, K., Millar, L., & Swinburn, B. (2011). Impact of "traffic-light" nutrition information on online food purchases in Australia. *Australian and New Zealand Journal of Public Health*, *35*(2), 122–126. https://doi.org/10.1111/j.1753-6405.2011.00684.x

Sanjari, S. S., Jahn, S., & Boztug, Y. (2017). Dual-process theory and consumer response to front-of-package nutrition label formats. *Nutrition Reviews*, *75*(11), 871–882. https://doi.org/10.1093/nutrit/nux043

Santé Publique France. (2020). *Nutri-Score*.

Santé Publique France. (2022). *CONDITIONS OF USE OF THE « NUTRI-SCORE » LOGO*.

Santos, O., Alarcão, V., Feteira-Santos, R., Fernandes, J., Virgolino, A., Sena, C., Vieira, C. P., Gregório, M. J., Nogueira, P., Graça, P., & Costa, A. (2020). Impact of different front-of-pack nutrition labels on online food choices. *Appetite*, *154*(August). https://doi.org/10.1016/j.appet.2020.104795

Savelli, E., Bravi, L., Francioni, B., Murmura, F., & Pencarelli, T. (2020). PDO labels and food preferences: results from a sensory analysis. *British Food Journal*, *123*(3). https://doi.org/10.1108/BFJ-05-2020-0435

Savelli, E., Bravi, L., Francioni, B., Murmura, F., & Pencarelli, T. (2021). PDO labels and food preferences: results from a sensory analysis. *British Food Journal*, *123*(3), 1170–1189. https://doi.org/10.1108/BFJ-05-2020-0435

Schamel, G. (2007). Auction markets for specialty food products with geographical indications. *Agricultural Economics*, *37*(2–3), 257–264. https://doi.org/10.1111/J.1574-0862.2007.00272.X

Schulz, L. L., Schroeder, T. C., & White, K. L. (2012). Value of Beef Steak Branding: Hedonic Analysis of Retail Scanner Data. *Agricultural and Resource Economics Review*, *41*(2), 260–273. https://doi.org/10.1017/S1068280500003397

Shangguan, S., Afshin, A., Shulkin, M., Ma, W., Marsden, D., Smith, J., Saheb-Kashaf, M., Shi, P., Micha, R., Imamura, F., & Mozaffarian, D. (2019). A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices. *American Journal of Preventive Medicine*, *56*(2), 300–314. https://doi.org/10.1016/j.amepre.2018.09.024

Shin, S., Puri, J., & Finkelstein, E. (2023). A randomized trial to evaluate the impact of Singapore's forthcoming Nutri-grade front-of-pack beverage label on food and beverage purchases. *International Journal of Behavioral Nutrition and Physical Activity*, *20*(1). https://doi.org/10.1186/s12966-023-01422-4

Shogren, J. F., Shin, S. Y., Hayes, D. J., & Kliebenstein, J. B. (1994). Resolving Differences in Willingness to Pay and Willingness to Accept Jason F . Shogren , Seung Y . Shin , Dermot J . Hayes and James B . Kliebenstein Source : The American Economic Review , Vol . 84 , No . 1 (. *The American Economic Review*, *84*(1), 255–270.

Sogn-Grundvåg, G., Larsen, T. A., & Young, J. A. (2014). Product Differentiation with Credence Attributes and Private Labels: The Case of Whitefish in UK Supermarkets. *Journal of Agricultural Economics*, *65*(2), 368–382. https://doi.org/10.1111/1477-9552.12047

Stanley, L. R., & Tschirhart, J. (2012). *Hedonic Prices for a Nondurable Good : The Case of Breakfast Cereals Author (s): Linda R . Stanley and John Tschirhart Reviewed work (s): Source : The Review of Economics and Statistics , Vol . 73 , No . 3 (Aug ., 1991), pp . 537-541 Published by : . 73*(3), 537–541.

Staudigel, M., & Trubnikov, A. (2022). High price premiums as barriers to organic meat demand? A hedonic analysis considering species, cut and retail outlet*. *Australian Journal of Agricultural and Resource Economics*, *66*(2), 309–334. https://doi.org/10.1111/1467-8489.12472

Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a Measure of the Motives Underlying the Selection of Food : the Food Choice Questionnaire Department of Psychology , St George ' s Hospital Medical School , London. *Appetite*, *25*, 267–284.

Stiletto, A., Cei, L., & Trestini, S. (2023). A Little Bird Told Me. . . Nutri-Score Panoramas from a Flight over Europe, Connecting Science and Society. *Nutrients*, *15*(15), 3367.

Stiletto, A., & Trestini, S. (2022). Is it really a piece of cake to label Geographical Indications with the Nutri-Score ? Consumers ' behaviour and policy implications. *PLoS ONE*, *17*(11), 1–18. https://doi.org/10.1371/journal.pone.0277048

Storcksdieck Gennat Bonsmann, S., Marandola, G., Ciriolo, E., Van Bavel, R., & Wollgast, J. (2020). *Front-of-pack nutrition labelling schemes: a comprehensive review* (Publications Office of the European Union (ed.)). Publications Office of the European Union. https://doi.org/10.2760/436998

Sutherland, L. A., Kaely, L. A., & Fischer, L. (2010). Comment on Guiding Stars: The effect of a nutrition navigation program on consumer purchases at the supermarket. *Nutrition in Clinical Practice*, *25*(5), 560–561. https://doi.org/10.1177/0884533610379856

Szathvary, S., & Trestini, S. (2014). A Hedonic Analysis of Nutrition and Health Claims on Fruit Beverage Products. *Journal of Agricultural Economics*, *65*(2), 505–517. https://doi.org/10.1111/1477-9552.12056

Talati, Z., Norman, R., Pettigrew, S., Neal, B., Kelly, B., Dixon, H., Ball, K., Miller, C., & Shilton, T. (2017). The impact of interpretive and reductive front-of-pack labels on food choice and willingness to pay. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), 1–10. https://doi.org/10.1186/s12966-017-0628-2

Temple, N. J. (2020). Front-of-package food labels: A narrative review. *Appetite*, *144*(October 2019), 104485. https://doi.org/10.1016/j.appet.2019.104485

Ter Borg, S., Steenbergen, E., Milder, I. E. J., & Temme, E. H. M. (2021). Evaluation of nutri-score in relation to dietary guidelines and food reformulation in the Netherlands. *Nutrients*, *13*(12). https://doi.org/10.3390/nu13124536

Thøgersen, J., & Nohlen, H. U. (2022). *Consumer Understanding of Origin Labeling on Food Packaging and Its Impact on Consumer Product Evaluation and Choices: A Systematic Literature Review.*

Thorndike, E. L. (1920). A Constant Error in Psychological Ratings. *Journal of Applied Psychology*, *4*(1), 25–29. https://ci.nii.ac.jp/naid/30013652235/

Thunström, L., & Rausser, G. (2008). The marginal willingness to pay for health-related food characteristics. *Acta Agriculturae Scandinavica, Section C — Food Economics*, *5*(3–4), 194–206. https://doi.org/10.1080/16507540903064235

Török, Á., & Moir, H. V. J. . (2018). The market size for GI food products – evidence from the empirical economic literature. *Studies in Agricultural Economics*, *120*, 134–142.

Townsend, M. S. (2010). Where is the science? What will it take to show that nutrient profiling systems work? *Erican Journal of Clinical Nutrition*, *91*(4), 1109S-1115S.

Trestini, S., & Stiletto, A. (2020). Does Italian origin really determine a price premium for fluid milk? Evidences from a hedonic price analysis. *Economia Agro-Alimentare*, *22*(1), 1–22. https://doi.org/10.3280/ecag1-2020oa10064

Valenzuela, A., Zambrano, L., Velásquez, R., Groff, C., Apablaza, T., Riffo, C., Moldenhauer, S., Brisso, P., & Leonario-Rodriguez, M. (2022). Discrepancy between Food Classification Systems: Evaluation of Nutri-Score, NOVA Classification and Chilean Front-of-Package Food Warning Labels. *International Journal of Environmental Research and Public Health*, *19*(22), 14631. https://doi.org/10.3390/IJERPH192214631

Vandecandelaere, E., Samper, L. F., Rey, A., Daza, A., Mejía, P., Tartanac, F., & Vittori, M. (2021). The

geographical indication pathway to sustainability: A framework to assess and monitor the contributions of geographical indications to sustainability through a participatory process. *Sustainability (Switzerland)*, *13*(14), 1–20. https://doi.org/10.3390/su13147535

Verbeke, W. (2005). Agriculture and the food industry in the information age. *European Review of Agricultural Economics*, *32*(3), 347–368. https://doi.org/10.1093/EURRAG/JBI017

Vickrey, W. (1961). Counterspeculation, auctions, and competitive sealed tenders. *Journal of Finance*, *16*, 8–37.

Vlassopoulos, A., Katidi, A., Savvidou, T., & Kapsokefalou, M. (2022). Alignment of Nutri-Score with Mediterranean Diet Pyramid: A Food Level Analysis. *Nutrients*, *14*(23). https://doi.org/10.3390/nu14235097

Vyth, E. L., Steenhuis, I. H., Vlot, J. A., Wulp, A., Hogenes, M. G., Looije, D. H., Brug, J., & Seidell, J. C. (2010). Actual use of a front-of-pack nutrition logo in the supermarket: consumers' motives in food choice. *Public Health Nutrition*, *13*, 1882–1889. https://doi.org/10.1017/S1368980010000637

WHO. (2019). *Guiding principles and framework manual for front-of- pack labelling for promoting healthy diet*.

WHO. (2020a). *Appendix: Detailed description of additional validation studies that may be considered to select and evaluate a front-of-pack labelling scheme*.

WHO. (2020b). *World health statistics 2020: monitoring health for the SDGs, sustainable development goals.*

Withall, J., Jago, R., & Cross, J. (2009). Families' and health professionals' perceptions of influences on diet, activity and obesity in a low-income community. *Health and Place*, *15*(4), 1078–1085. https://doi.org/10.1016/j.healthplace.2009.05.006

Włodarek, D., & Dobrowolski, H. (2022). Fantastic Foods and Where to Find Them—Advantages and Disadvantages of Nutri-Score in the Search for Healthier Food. *Nutrients*, *14*(22). https://doi.org/10.3390/nu14224843

Wongprawmas, R., Mora, C., Pellegrini, N., Guiné, R. P. F., Carini, E., Sogari, G., & Vittadini, E. (2021). Food choice determinants and perceptions of a healthy diet among Italian consumers. *Foods*, *10*(2). https://doi.org/10.3390/foods10020318

World Health Organization. (2020). World health statistics 2020: monitoring health for the SDGs, sustainable development goals. In *Geneva: World Health Organization; 2020. Licence:*

World Health Organization. (2021). *Malnutrition: Fact sheets*. https://www.who.int/news-room/fact-sheets/detail/malnutrition#:~:text=1.9 billion adults are overweight,million were overweight or obese.

Zhang, G., Wang, C. L., Liu, J., & Zhou, L. (2023). Why do consumers prefer a hometown geographical indication brand? Exploring the role of consumer identification with the brand and psychological ownership. *International Journal of Consumer Studies*, *47*(1), 74–85. https://doi.org/10.1111/ijcs.12806

Zhang, S., Sun, Y., Yu, X., & Zhang, Y. (2023). Geographical Indication, Agricultural Products Export and Urban–Rural Income Gap. *Agriculture (Switzerland)*, *13*(2), 1–16. https://doi.org/10.3390/agriculture13020378

Chapter 3

A Little Bird Told Me… Nutri-Score Panoramas from a Flight over Europe, Connecting Science and Society

Abstract

Within the Farm to Fork Strategy, the European Commission ask for a unified Front Of Pack nutritional label for food to be used at the European level. The scientific debate identified the Nutri-Score (NS) as the most promising candidate, but within the political discussion, some Member States brought to attention several issues related to its introduction. This misalignment led to a postponement of the final decision. With the aim to shed some light on the current stances and contribute to the forthcoming debate, the objective of the present work is to understand to what extent scientific research addresses the issues raised by the general public. We applied a structural topic model to tweets from four European countries (France, Germany, Italy, Spain) and to abstracts of scientific papers, all dealing with the NS topic. Different aspects of the NS debate are discussed in different countries, but scientific research, while addressing some of them (e.g., the comparison between NS and other labels), disregards others (e.g., relations between NS and traditional products). It is advisable, therefore, to widen the scope of NS research to properly address the concerns of European society and to provide policymakers with robust evidence to support their decisions.

3.1. Introduction

Currently, overnutrition is the main nutritional issue at the global level, as 24.1% of adults are overweight and obese—and only 5.8% are underweight [1]. To reduce and prevent this issue, Front-Of-Pack labels (FOPLs) have been widely used both at the global and European levels to improve the nutritional and health habits of the population [2]. These labels, providing concise and easy-to-understand information about the nutritional profile of foods on the front of the pack, have a double goal: to help consumers to identify the overall nutritional quality of food, thus guiding them towards healthier food choices [3] and to encourage food industries to

reformulate and improve their products [4].

At the European level, multiple FOPLs currently co-exist, such as nutrient-specific labels (e.g., Reference Intake), endorsement schemes (e.g., GreenKeyhole), and summary labels (e.g., Nutri-Score), which are adopted on a voluntary basis by EU countries and firms. However, as FOPLs are not mandatory yet, food industries can take advantage of its adoption, using the labels only on products whose sales value could be increased by use of the FOPLs [5]. To overcome this issue, the Farm to Fork (F2F) strategy stresses the need to make the use of FOP nutritional labelling mandatory on pre-packed foods, using a harmonized standard across the EU. The Nutri-Score (NS) is the most promising FOP candidate to be used, being considered the most efficient in helping consumers to dis-criminate products according to their nutritional profile [6–8]. The NS is a five-step col-our-graded nutrition label (Figure 3.1), ranging from the healthiest category, the dark green (category A), to the unhealthiest one, the red one (category E). As a summary label, it provides an overall assessment of a food's nutritional value, considering favorable (i.e., content of fruits and vegetables, fibre, protein, nuts, rapeseed, and olive oil) and unfavorable nutrients (i.e., content of calories, fat, sugars, and salt) for classifying foods into one out of the five categories.

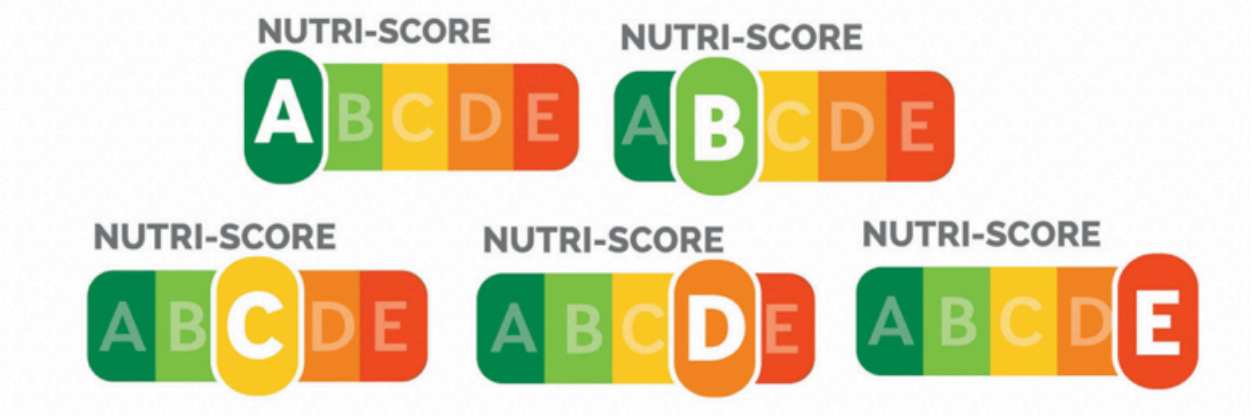

Figure 3.1. Nutri-Score labels

Despite being currently adopted in several European countries, the NS is stimulating an active debate, while it has faced (and is still facing) oppositions. In France, after its first proposal in 2013 (which led to the final adoption in 2017), an outcry was raised, especially from agro-

food companies [9]. The subsequent request of the EU (within the F2F strategy) to use it on a mandatory basis in all EU countries widened the debate to other Member States. In Italy, the NS adoption is a recurrent theme of the agricultural political debate, where the national government supports the major agro-food firms [10] in their claim of the NS as a penalizing tool for Mediterranean and traditional products [10,11], including wines[6]. Similarly, in Spain, where the NS was adopted in 2021, concerns were repeatedly raised about supposed inconsistencies in the classification of some traditional products, such as olive oil [12] (the NS algorithm was modified at a later stage to positively value the nutritional qualities of olive oil).

In light of these discussions, there is a clear need, at the EU level, to shed some light on the contrasting positions existing within the European context, to reach a general agreement among Member States. This is all the more important considering that the European Commission has recently postponed the presentation of the proposal of a single FOPL to 2024 (i.e., to the next European legislature) because of contrasts between EU countries and the lack of sufficient data to support the label. In addition, to date, the 150 papers that focus on the NS label are not equally distributed across Europe. Specifically, France (20.5% of publications), which is the country where the NS was initially adopted, has produced two times the publications of other countries, such as Spain (10.9%) or Italy (7.0%). Considering this, the scientific literature could be in some way biased, focusing only on the aspects related to the NS that are more interesting for the countries in which the NS topic is more addressed. However, to decide what FOPL to adopt at the EU level, the European Commission needs to have a complete overview of the NS topic, evaluating all its aspects. In this respect, it is important to take an informed policy decision, to gain insights about the most relevant aspects raised by citizens and researchers. In line with this consideration, in this study we aim to provide an overview of the Nutri-Score discussion in Europe, highlighting to what extent scientific research has addressed the concerns raised by public opinion. To do so, we aim to answer the following research questions (RQ):

RQ1: What are the topics raised by the public debate on the NS label in different EU countries?

RQ2: To what degree does the scientific research on NS address all the aspects that have

[6] available at: https://foodmatterslive.com/article/nutri-score-proposal-alcohol-lowest-ranking-grade-criticised-france-italy/; accessed on 14 June 2023

emerged from the public debate?

The data collection process and the methodological approach used to analyze textual data from the two sources (i.e., Twitter and the scientific literature) are detailed in the next section. In Section 3, we report the results separately for Twitter and the literature analysis and, within the former, for each considered country. A thorough and wide-ranging discussion is provided in Section 4, where comparisons of country-specific NS discourses are critically illustrated, while public and scientific debates are confronted. Some conclusions are provided at the end of the manuscript, stressing the implications of our results for both policy action and scientific research.

3.2. Materials and Methods

To answer RQ1, a topic-modeling analysis has been conducted on tweets posted on Twitter (RQ1) in four different EU countries (France, Germany, Italy, and Spain). Indeed, as Twitter is the social network platform most used by institutions, industries, and organizations to share information or to discuss legislations [13], it is the most suitable tool to catch the public discussions on NS. Several scholars have already analyzed tweets' content for comparing experts' opinions on specific topics, such as cardiovascular diseases [14], or to understand public opinion on hot topics, such as COVID-19 in 2020 [15]. In addition, Ola and Sedig [16] and Pershad et al. [17] used Twitter analysis in health-related contexts, and Septia Irawan et al. [18] used it within the policy framework to understand the perceptions and sentiment of public discourse on FOPLs in the EU.

On the other hand, to understand if the scientific literature has covered all the aspects that have emerged from the public debate, thus providing the European Commission with an appropriate overview on the NS topic, a comparison between the topics that have emerged from the tweets analysis and the scientific research has been conducted (RQ2). To reach this objective, a systematic literature review of papers dealing with the NS issues and a topic-modelling analysis on them have been performed.

To properly compare the scientific literature with the Twitter debate on NS, it is necessary to adopt consistent and homogeneous methodological strategies both to retrieve the initial material (i.e., scientific documents and tweets) and to analyze its content. In the following

subsections, we first describe the process of data collection and the pre-processing of the textual material, and then we provide a brief overview of the topic-modeling technique used to identify the main topics. All statistical analyses were performed using the R software (version 4.2.2).

3. 2.1. Data Collection and Pre-Processing

3.2.1.1. Tweets

To assure consistency with the literature analysis (Section 3.2.1.2), the analysis of the Twitter data was conducted on tweets mentioning the words "Nutriscore" or "Nutri-score" that were posted between January 2017 and January 2023. Before 2017, tweets about the NS were in fact scanty. Retweets are excluded from the analysis, a procedure also adopted in other studies analyzing the contents of tweets (see, for example, [15,19]). Specifically, while retweets might signal agreement with (or sharing of) someone else's opinion, tweets of popular users (e.g., politicians, influencers, celebrities) are more likely to be retweeted than tweets from ordinary users. As such, the inclusion of retweets in our analysis might have led to an overrepresentation of the interests of relatively few individuals, with the subsequent introduction of a bias in the results.

In order to work with a sufficiently high number of tweets and thus conduct a meaningful statistical analysis, we decided to restrict the scope to the four countries with the highest number of tweets about the NS: France, Germany, Italy, and Spain. In this respect, the country of origin of the tweets was determined on the basis of the tweet language. The assignment of the location of tweets based on the language in which they were written is a delicate step and it therefore deserves further attention. Twitter can provide geolocation information for tweets, but only few users activate this specific function. As a result, the majority of tweets cannot be linked to a specific country of origin, hence the decision to rely on the tweets' language.

It is important to note that the use of the tweet language is not free of possible biases. Specifically, two kinds of errors are possible:

(i) False positives: a tweet is attributed to a certain nationality (because it is written in the native language of that country) when it is in fact coming from another country;

(ii) False negatives: a tweet is not attributed to the correct nationality when it is in fact

coming from that country, because it is not written in the native language of that country.

Both types of errors are more frequent for languages that are widely used outside their countries, with English representing the major concern. False positives can also appear, however, for the languages considered in our analysis: French is used in Belgium, Switzerland, Canada, and some African countries; German in Austria and Switzerland; Italian in Switzerland; and Spanish in Latin America. In the case of languages used in neighboring European countries, the main country (France, Germany, Italy) always has a far larger population, assuring the attribution errors are minimal. For languages used outside Europe, on the other hand, the assurance is given by the topic addressed. NS is in fact, to date, a subject debated almost exclusively in Europe, where it was devised and implemented. The number of tweets from major non-European countries was assessed using the Twitter geolocation function and compared with geolocated tweets from the four countries included in the analysis. Overall, the United States, Canada, Brazil, Argentina, China, Japan, India, and Australia accounted for 40 tweets, while 1497 tweets were posted in the four European countries.

Conversely, to assess the relevance of false negatives, we retrieved the geolocated tweets from the four countries and we counted the number of tweets written in the non-native language. As reported in Table 1, in three of the four countries, tweets posted in the native language accounted for more than 80% of the tweets, while a lower share was observed in Italy. It is important to note that false negatives, while they might still introduce some bias reducing a country's population of tweets, do not cause a misallocation of tweets.

Table 3.1. Number of geolocated tweets in the considered period of analysis (2017–2023) posted in non-native languages

Country	Number of Tweets	Tweets in the Native Language	Share of Native Tweets (%)
France	568	496	87.3
Germany	167	139	83.2
Italy	229	167	72.9
Spain	533	466	87.4
Total	1497	1268	84.7

The use of the language criterium to assign nationality to tweets provided 71,089 original tweets. These tweets were pre-processed following a procedure drawn from Lyu et al. [19]. Specifically, we removed URLs, non-ASCII characters and numbers, and we dropped

similar tweets. Indeed, similar and duplicate tweets stem, in most of the cases, from retweets posted without the specific retweeting function, which therefore do not allow them to be identified as retweets in the first place. The similarity between tweets was assessed by computing the cosine similarity for each pair of tweets based on the document-term matrix, a matrix where rows represent tweets, columns correspond to terms, and single cells contain 1 if a term is present in a tweet and 0 if it is not. The cosine similarity is given by the dot products between two rows. When the similarity between two tweets was higher than 90%, only one of them was retained. This process led to four national databases consisting, overall, of 65,723 tweets.

3.2.1.2. Scientific Literature

The collection of scientific documents was performed following the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analysis for protocols) guidelines [20]. The first step of the protocol consists in planning the review, whose pivotal point is the definition of the objective. In this respect, as discussed in the introduction, our aim is to have a broad view of the scientific literature investigating the NS label, irrespective of the specific scientific subject area.

In line with this objective, we decided to begin the second step (i.e., conducting the review) choosing a loose search string:

TITLE-ABS-KEY(Nutriscore OR Nutri-score)

The search was performed in the two largest scientific databases, Scopus and Web of Science, in January 2023, considering only published original articles written in English (notes, letters, conference papers, editorials, and reviews were excluded). Although scholars usually extend the research to other sources of data, not necessarily scientific (see for instance [21]), Scopus and Web of Science are considered the most comprehensive databases of high-quality peer-review articles [22–24]. This initial step provided 329 articles. This set of articles was reduced, through successive phases, to 150 articles. Specifically, 156 duplicate articles deriving from the merging of the two sources (Scopus and Web of Science) were initially discarded. After reading the titles and the abstracts of the remaining 173 articles, 23 additional documents were excluded. Of the 23 excluded papers, 2 are additional reviews not excluded from the initial search, 17 are medical articles referring to a homonymous nutritional screening tool for oncological patients [25], and 4 simply do not deal with the NS.

3.2.2. Data Analysis—Topic Modeling

The analysis of the contents of tweets and of the scientific literature was performed in R using structural topic modeling (STM) (stm package, [26]). STM is a quantitative text analysis technique that allows for the retrieval of underlying topics from a corpus of documents and that is increasingly exploited in several research fields (some examples are [27–29]). Specifically, the STM was applied to five corpora separately: the corpus of the abstracts of scientific articles and the four national corpora of tweets. The STM models were estimated on tweets in their original language. English translation was used at a later stage only to interpret the results.

The main advantage of STM and similar text analysis techniques consists in the ability to deal with a large number of documents that might be hardly tractable by one or a few researchers. In our case, this is particularly valuable for the analysis of tweets, while the size of the scientific literature corpus would have allowed the performance of a standard literature review. However, a robust comparison between different text corpora requires the analysis of them with identical methodologies. In addition, using such a technique proves even more useful when the objective is to compare different sets of documents, since it assures the removal of any possible bias that might be inadvertently introduced by the discretion of the researcher. Compared with other quantitative text analysis techniques, STM allows a document to include multiple topics, thus better resembling the complexity of scientific communication and public opinion.

STM was devised by Roberts et al. [30,31] and is part of a family of techniques whose objective is to extract from a corpus of documents its content. This content is represented by the topics, which are identified as latent structures in the corpus. The STM relies on the assumption of a specific generative process for the corpus at hand. The generative process explains how the corpus came to be created, starting from the selection of each single word of each document. For clarity, we provide a brief summary of the process. First, the total number of words contained in a document d (Nd) is extracted from a Poisson distribution. Then, given K topics, for each document of the corpus a vector of topic proportions (θd) is extracted from a logistic normal distribution. This vector represents the proportion of a document that addresses each k topic, which is commonly defined as the topical prevalence. As a third step, based on θd, the topic of each nth word is determined. The last step consists of the drawing of each specific nth word. Each topic is characterized by a specific word distribution, which is called the topical content. The nth word is thus drawn from the distribution of the relative topic

[31].

Exploiting a Bayesian approach, the STM walks this generative process backwards and, starting from the words observed in the documents, retrieves the topical content and the topical prevalence of each topic. The characteristics of the assumed generative process confer on the STM some interesting properties: (i) each document is considered a mixture of topics; (ii) correlation between topics can be estimated; (iii) covariates can be used to model topical prevalence and/or topical content. The last aspect is particularly innovative, since it allows either the proportions of the topic in the corpus (topical prevalence) or the words used to identify a topic (topical content) to vary according to documents' pre-specified characteristics.

With respect to our analysis, the first step was to structure the model, which included the selection of the covariates. For the four models set for the analysis of tweets, we included time as a covariate for modeling topical prevalence, using splines to account for possible non-linear relationships. Time is defined as the month when a tweet was posted. We decided not to include time as a covariate in the literature model. Despite the fact that the topics addressed by the scientific literature might vary over time, considering the time needed to prepare a scientific paper and to go through the whole publication process, we deem the time span of the analysis (2017–2023) too short to highlight any meaningful trend in the published articles.

The second step entails the decision of the number of topics for each model. In fact, while STM infers autonomously the content of the topics, their number must be specified in advance by the researcher. The selection of the optimal number of topics was performed estimating several models with different numbers of topics and then analyzing the average exclusivity (i.e., the specificity of each word to a given topic) and semantic coherence (i.e., probability of a set of words to occur together in the same document) measures of each model [26,32]. The best model is the one that scores high in both metrics, but where neither of the two dominates the other [26]. When this criterium alone was not sufficient to uniquely identify an optimal model, we restricted the analysis to the best-performing models, computed the overall average values of exclusivity and semantic coherence across the models, and selected the model with the highest share of topics with a value of both metrics above the respective average.

The last intervention of the researcher is the naming of the topics. Since STM returns the topics as words distributions, the researcher needs to infer the content of the topic and assign it a name. This is usually achieved by either analyzing the word distributions or the most

representative documents of a topic. Adopting this second strategy, we selected, for each topic in each model, the documents in which that topic had a prevalence higher than 75% and, based on their content, we named the topic. To improve the consistency in the identification of the name and the content of a topic, we followed the procedure in Lyu et al. [19]. Two authors independently analyzed half of the representative documents and determined the name of the topic through group discussion. Afterwards, the third author checked the consistency of the name with the content of the most representative documents and the final name for the topic was finally selected, after additional discussion when needed.

3.3 Results

3.3.1. Twitter Analysis

As reported in Table 3.2, the search identified 65,723 tweets discussing NS in the four countries considered in the analysis. Weighting the number of tweets by the number of Twitter users shows that the NS topic is more popular in France, while it is relatively less debated in Germany. The estimates in Table 2 should be considered as indicative, as figures on the Twitter penetration in each country appear to be uncertain. The number of Twitter users were retrieved from web searches[7] and refer to 2022.

Table 3.2. Number of original tweets about NS

Country	Number of Tweets	Tweets/(Year × 1000 Users)
France	26,535	440
Germany	11,431	250
Italy	8981	310
Spain	18,776	360
Total	65,723	350

Figure 3.2. presents the yearly number of tweets in each country. In this respect, different temporal patterns can be observed in the four countries, despite an increasing trend being observed everywhere. In France, the 'homeland' of NS, the interest of Twitter users for the topic was relatively high and constant from 2018 to 2020, despite a sharp increase being observed in the last two years with a peak in 2022. Germany and Spain are characterized by some peaks

[7] available at:https://www.statista.com/statistics/242606/number-of-active-twitter-users-in-selected-countries/; https://business.trustedshops.it/blog/gruppi-utenti-social-media#:~:text=Con%204%2C79%20milioni%20di,uomini%20e%20il%2030%25%20donne and accessed on 17 June 2023

(in 2019 and in 2022 in Germany and in 2021 in Spain), while Italy displays a more constant growth.

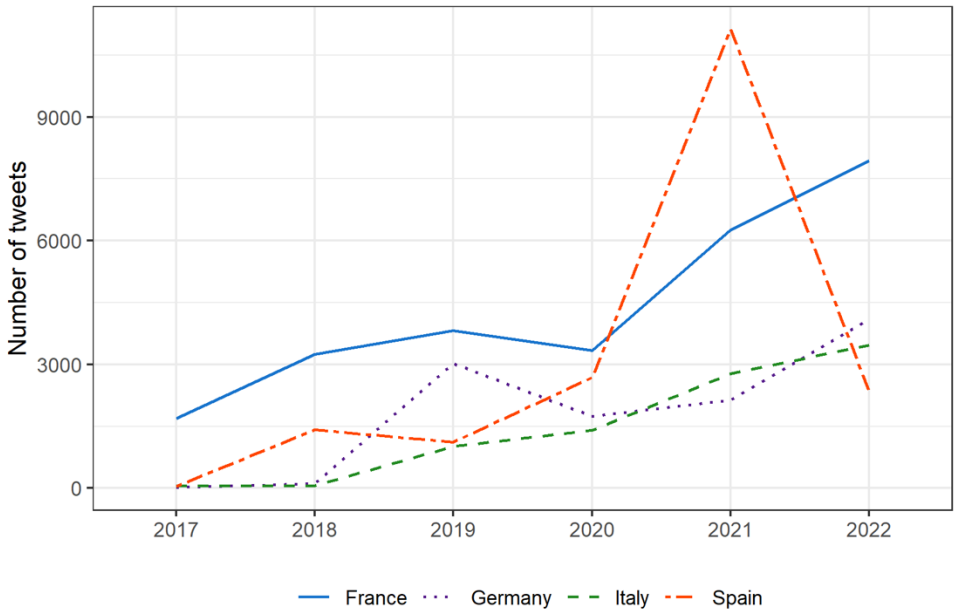

Figure 3.2. Yearly number of tweets by country

3.3.1.1. Italy

As described in Table A3.1 and represented in Figure 3.3b, nine topics emerged from the tweets analysis in Italy. Most of them describe the Italian's contrasting position on the NS adoption (T5: "NS adoption in EU Countries") from both a scientific (T7: "NS calculation system and comparison between NS and Nutrinform") and a political point of view (T2: "Role and position of Stakeholders and Institutions towards NS"; T3: "Political disputes on NS"; T8: "Criticism to the Health Minister's consultant—Walter Ricciardi—for supporting the NS system"). Specifically, different topics deal with a possible negative effect of the NS adoption on Mediterranean products, considering foods (T1: "Debate on novel foods and NS"; T4: "Implications of NS adoption for the Mediterranean products"; T9: "Criticism for NS values given to Traditional vs. Junk/Processed foods") and wine (T6: "Position against the black label on wine).

The NS adoption (T5) in Italy seems to be a strongly debated topic, especially in recent years. Looking at the contents of the tweets, general opposition to the NS emerges, so much so that 13.2% of the corpus is dedicated to the comparison between NS and Nutri-Inform battery, the FOPL proposed by the Italian Ministry of Agriculture to the European Commission and

officially presented in February 2022 as an alternative to the NS. However, the main concern of Twitter users in this country seems to be related to a possible negative effect of the NS adoption on typical products of the Mediterranean diet (T4) and on traditional products (T9). These considerations stem from the evidence that most of the high-value PDO and Protected Geographical Indication (PGI) products, such as Parmigiano Reggiano PDO, Mozzarella di Bufala Campana PDO, or Prosciutto di Parma PDO, are assigned a negative grade by the NS system[8], as is also widely acknowledged in T4. This negative sentiment is strengthened by the fact that some ultra-processed foods, generally considered as low-quality products, received positive NS values (T9). The same goes for Novel foods, such as insect-based products (T1), which are considered low-quality products by Italian users and not in line with the national culinary traditions. Following the same path, 13.5% of the corpus contains opinions of consumers and politicians towards the possibility to label wines and other alcoholic beverages with a "black F score", in order to stress the negative effect of alcohol consumption on health, independently of the dose (T6).

Compared with other countries, tweets in Italy are strongly linked to political debates (T2; T3; T8), reflecting the strong position of the Italian government (T3), politicians, and stakeholders (T2) against the NS adoption. Tweets in T8 stress these aspects, showing how the favorable position of the Health Minister's consultant for the NS adoption has caused such a stir among politicians and citizens.

Looking at the topic's correlation patterns (Figure 3.3a), three different clusters emerged. The green one clearly represents the sentiment of national identity that drives the NS discussion in Italy, describing the possible negative effect on the Mediterranean diet products (T4), along with politicians' (T3) and stakeholders' (T2) positions towards this system. The red cluster collects all the tweets dealing with Italians' concerns about the NS algorithm, considering the contrasting evaluation given by this system to novel (T1) and ultra-processed foods (T9) with respect to traditional ones, including geographical indications (T9) and wines (T6). The light blue cluster represents instead the "objective side" of the discussion, which include both considerations about the spreading of NS throughout Europe (T5) and comments

[8] available at: https://www.ansa.it/canale_terraegusto/notizie/prodotti_tipici/2022/03/15/nutriscore-a-rischio-10-piatti-simbolo-con-i-formaggi-dop_965ef50b-0280-48a5-97f5-317c6782401b.html#:~:text=In%20pratica%20tutti%20i%20formaggi,Parmigiano%20Reggiano%20e%20Pecorino%20Romano and accessed on 22 June 2023

about the Italian alternative to the NS label (T7). Finally, tweets discussing the very specific topic T8 stand alone.

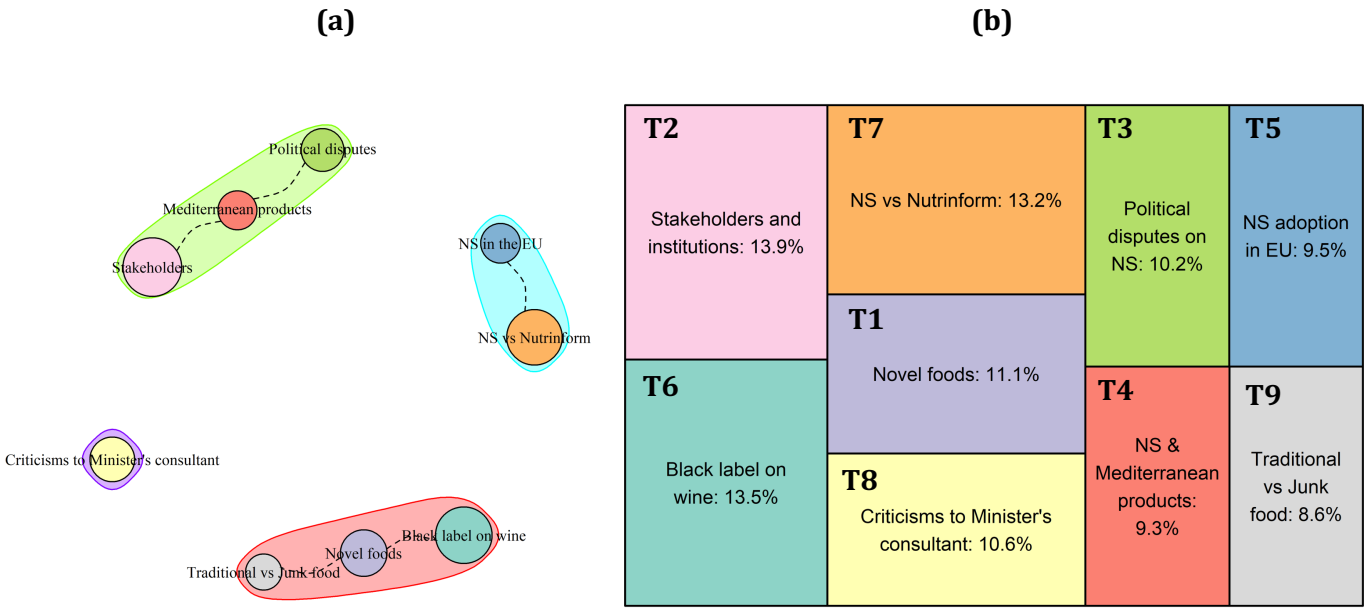

Figure 3.3. Topics' correlation patterns (a) and prevalence (b) of the topics in the Italian corpus of tweets

3.3.1.2. France

The analysis of tweets in France yielded seven topics, as described in Table A3.1 and reported in Figure 3.4b. Three of them (T1: "Health improvements through mandatory use and promotion of the NS"; T6: "Using the NS to improve transparency: pressures on producers"; and T7: "NS for contrasting health-related issues") deal with positive aspects of the NS labelling, one is focused on describing some inconsistencies in the algorithm (T4: "NS vs. traditional and industrial or ultra-processed foods"), two describe the adoption of the NS (T5: "NS adoption in retail chains") and the contrasting positions of industries (T2: "Supporting NS: lobbies hinder the adoption of NS"), and the last one deals with new score systems inspired by the NS (T3: "New score systems inspired by the NS).

In broad terms, results underlined that, according to the French twitter users, the NS adoption allows consumers to be more aware about the nutritional content of foods (T1), pushing them towards healthier food choices and thus reducing risks of health-related issues, such as cancer (T7). Indeed, the adoption of NS was strongly desired by French consumers, such that even the most reluctant producers and food industries bowed to the common will (T2; T5).

However, the major share of tweets (28.8%) regards some critical issues related to NS (T4). According to these Twitter users, the algorithm underlying this labelling poorly classified some products, such as the Protected Designation of Origin (PDO) and generic cheeses or beef, while promoting some ultra-processed foods, generally perceived as unhealthy due to the high product processing. Nevertheless, the system seems to be particularly appreciated in France, so much so that new labels that are similar to the NS have been proposed in recent years to measure, for instance, cybersecurity or corporate social responsibility.

Looking at the topic correlation patterns (Figure 3.4a), we can appreciate that most of the topics are highly correlated to each other (red squared), underlining some overlapping discussions among them. Indeed, all these topics deal with positive aspects related to the NS and its adoption. On the contrary, tweets regarding the debate on the negative NS evaluation given to traditional or ultra-processed foods (green dot) or those focusing on other score systems that are similar to NS (blue dot) seem to stand alone.

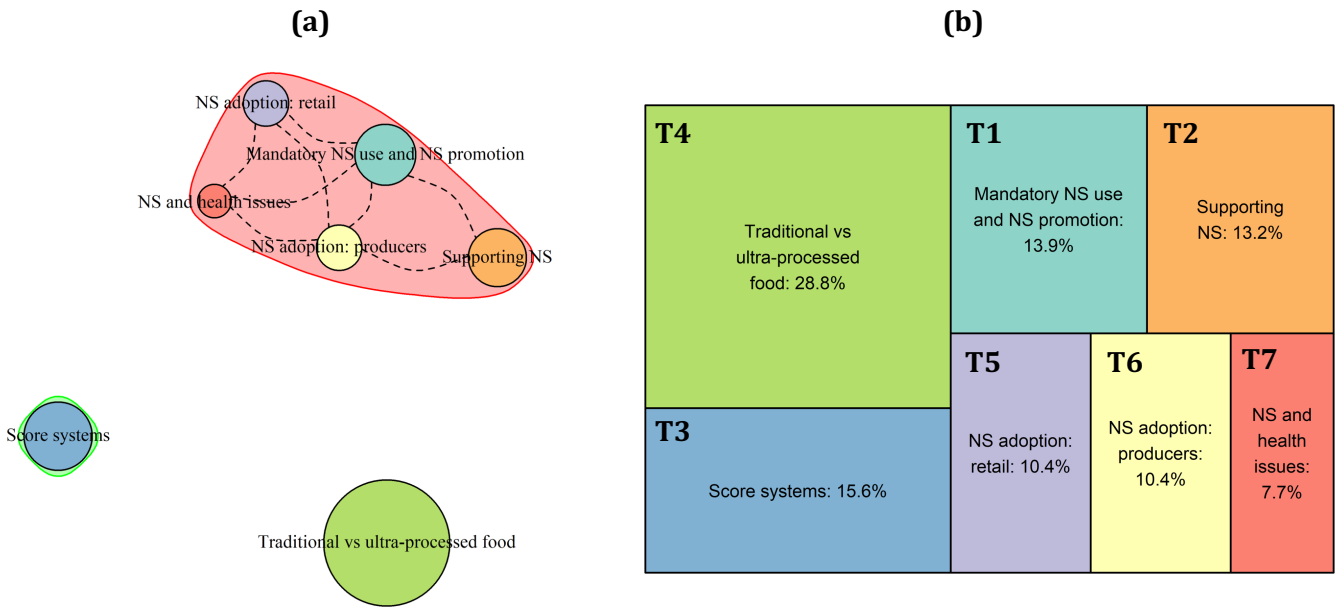

Figure 3.4. Topics' correlation patterns (a) and prevalence (b) of the topics in the French corpus of tweets

3.1.3. Germany

From the tweets' analysis in Germany, seven topics emerged, as described in Table A3.1 and represented in Figure 3.5b. Some of them deal with technical (T7: "How to properly use the NS"; T6: "Insights on the NS calculation system") and political (T5: "NS in the policy agenda"; T1: "Criticisms to the German Minister of Food and Agriculture—Julia Klöckner—for

opportunistically not supporting the NS") aspects linked to NS adoption (T2: "NS adoption in EU"), while others clearly adopt a judgmental perspective, stressing either the positive (T4: "Usefulness and positive aspects of NS") or negative (T3: "Criticisms towards NS classification of products") aspects of the NS.

In 2020, Germany adopted the NS label on a voluntary basis (T5), following the forerunner countries, such as France and Belgium (T2). This adoption has been positively welcomed by German consumers, as the NS is considered a simple and easy-to-understand label (T4), in such a way that in 12.2% of the corpus of tweets the then-Minister of Food, Julia Klöckner, is accused of having somehow hindered the adoption of this system, hiding a study reporting its benefits[9]. However, as previously discussed for the Italian and French cases, a good chunk of Twitter users (23.8%) questions the calculation system behind the NS (T3), as it penalizes some product categories while promoting others, without distinguishing between different products within the same category. Some users argue that the NS does not consider some elements important for the human organism, such as vitamins, even if it appears useful for providing a general idea of the overall nutritional quality of a given product (T7). Even more than in other countries, German Twitter users seem to have contrasting positions towards the NS, with some of them strongly supporting the label and others standing against this oversimplified system (T6).

This is reflected in the topics' correlation patterns (Figure 3.5a), which return three different clusters. Two of them can be distinguished on the basis of the general sentiment they convey. In the red cluster (T1, T2, T5), whose users might be identified as "NS lovers", NS is viewed in a quite positive light. Conversely, in the green cluster (T3, T7), whose users can be named "NS faultfinders", attention is brought to possible flaws in the NS system, whilst also discussing how to properly use and interpret this tool. Finally, the blue cluster (T4, T6), from a sentiment perspective, is more neutral in nature, its scope being limited to the provision of information about how the NS system works and how this determines its usefulness.

[9] available at: https://www.bmel.de/SharedDocs/Downloads/DE/_Ernaehrung/Lebensmittel-Kennzeichnung/MRI-finaler-Bericht-Naehrwertkennzeichnung.pdf?__blob=publicationFile&v=2 and accessed on 17 June 2023

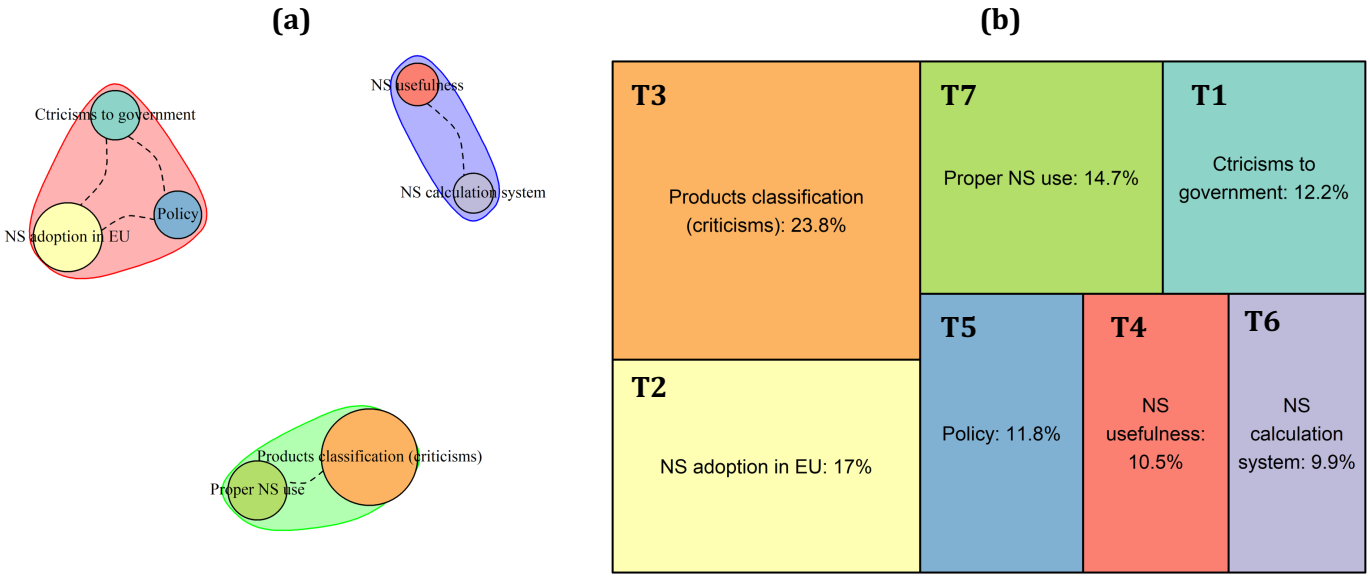

Figure 3.5. Topics' correlation patterns (a) and prevalence (b) of the topics in the German corpus of tweets

3.3.1.4. Spain

In Spain, the NS adoption has been greatly discussed, with ten topics emerging from the Twitter analysis (Figure 3.6b). Indeed, the NS adoption in Spain (T7: "NS adoption") has been widely debated, adopting either political (T5: "Political slip-ups on the NS adoption"), supply (T2: "Multinational companies against the NS adoption"), and demand perspectives (T1: "On the NS debate: seeking information"); whether scientists seem to support this label (T4: "Research support the NS"); or different criticisms of the calculation system (T3: "Criticisms towards the NS system"; T6: "NS calculation: possible chinks in the system"; T9: "NS calculation: technical aspects"), especially for undervaluing traditional Spanish products, such as the Hibernian ham (T8: "NS vs. traditional foods") or olive oil (T10: "NS vs. olive oil -and other traditional products-").

Spain was one of the first supporters of the NS label within the European context. Despite the Spanish government's intention to implement it since 2018, the official adoption of the label took place only three years later, in 2021, when more than 60 Spanish scientists and nutrition

professionals published a manifesto[10] in support of the implementation of the NS (T4), which is considered an effective tool to guide consumers towards healthier food choices (T7). Producers had suffered pressure from consumers, who asked major food companies to adopt this la-belling system, in aid of greater transparency (T2). However, as seen for the other countries, inconsistencies in the calculation system are also brought to the fore in Spain (T6), especially for not considering the meal as a whole—and rather evaluating the single ingredients—or for classifying some ultra-processed foods as the healthiest option (T6; T9). Along with this aspect, 6.1% of the corpus of tweets describes the general discontent of some Twitter users (T3) with respect to this label, which is considered too simple and not able to catch the real nutritional value of the products (T9). This is particularly true if traditional foods are considered (T8; T10), as they are highly penalized by the NS algorithm, with some industries proposing to exclude olive oil from the NS labelling (T10). In light of these controversies, some Twitter users suggested conferences and/or podcasts to follow in order to understand more in-depth what is behind the NS (T1) system, especially after the change in course of the Spanish government[11] is classified as a non-healthy product (T5).

Figure 3.6a clearly highlights the interlinkages between most of the topics. Indeed, in the Spanish case, there are no well-defined clusters of topics, as found for Italy or Ger-many, and to some extent in France. After the NS adoption, following the scientific evidence on the subject, several talking points seemed to be put on the table, all somehow interrelated.

[10] available at: https://www.agropopular.com/manifiesto-contra-nutriscore-180221/ and accessed on 23 June 2023

[11] available at: https://www.cope.es/actualidad/noticias/nutriscore-gana-espacio-super-mientras-gobierno-debate-regula-20211114_1616973 and accessed on 23 June 2023), which, in 2021, lashed out against the French system after noting that extra-virgin olive oil (of which Spain is the world's leading producer

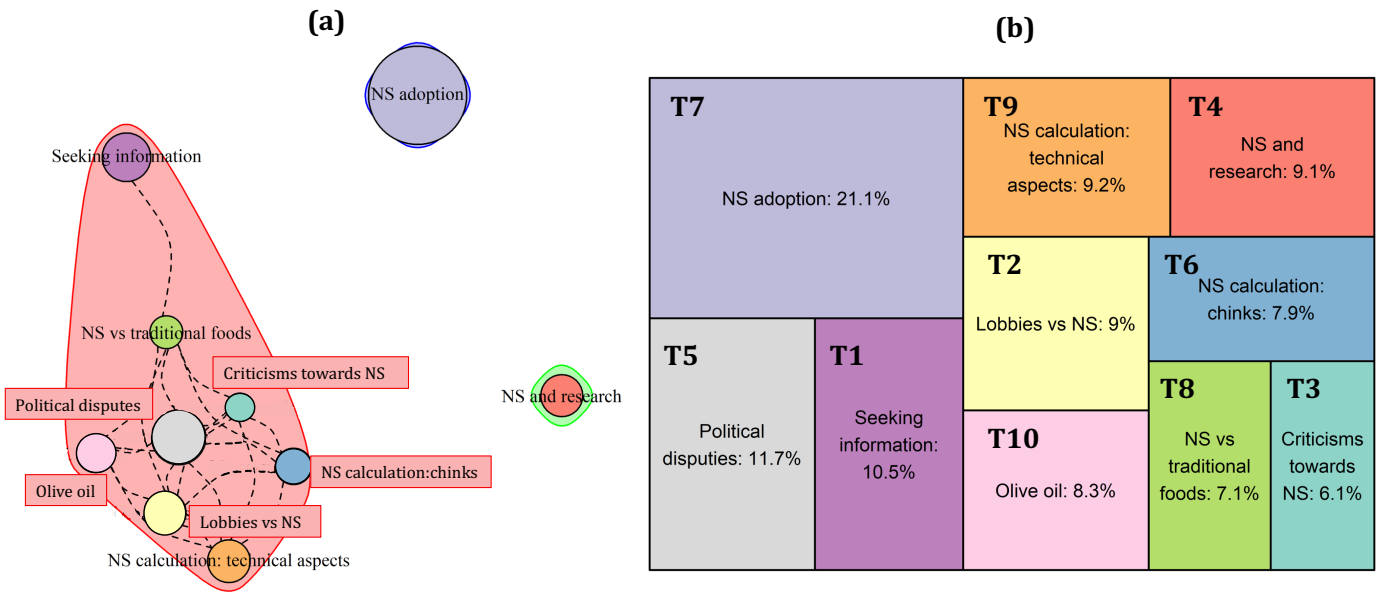

Figure 3.6. Topics' correlation patterns (a) and prevalence (b) of the topics in the Spanish corpus of tweets

3.3.2. Literature Analysis

The scientific literature on NS is, as is the topic it addresses, relatively new. The first two papers appeared in 2017, but in six years the strand grew to reach the one hundred and fifty articles included in our analysis. This trend is similar to what was observed in the tweets, and a similarity between the two debates was also observed when considering the geographical aspect. According to Scopus's statistics, most of the scientific articles on NS are in fact produced in France (20.5%), followed mainly by other European countries.

The best STM model to describe the literature corpus is the one with ten topics, which are reported in Figure 3.7. In Table A3.2 in Appendix B3, we also report, for each topic, the ten most representative terms and three titles that are among the most exemplary documents for the topic (i.e., documents where the prevalence of the topic is highest), and the references of the documents where the topic constitutes at least 25% of the abstract. In contrast to what was observed for the Twitter analysis, no interesting correlation was observed between the topics. In this respect, a role is likely played by the low number of documents in the literature corpus.

According to the model results, the most prevalent topic in the NS literature was "Understanding of different FOP labels", which constitutes 17.7% of the corpus. The most exemplary documents of this topic usually compare different FOPLs in terms of under-standing and preference by consumers. Overall, most of them agree in identifying the NS as the most

understandable FOPL and the one that helps consumers the most in making healthier food choices [6,33,34]. However, some works detected that this advantage of the NS is not linked with a higher appreciation of this label compared with others [35–38]. For example, in comparing the NS with the Nutrinform label, Mazzù et al. [39] observed that Italian consumers consider the former too uninformative.

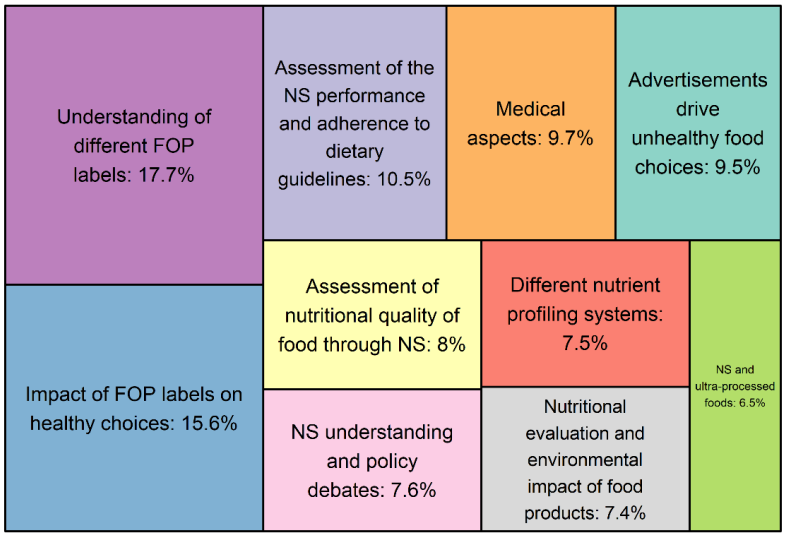

Figure 3.7. Estimated topic prevalence in the corpus of scientific abstracts

Other topics are related to the role of NS in the market and its relationship with consumers. Among these, "NS understanding and policy debates" (7.6% of the corpus) is similar to the previous one, despite focusing almost exclusively on the NS (instead of comparing multiple FOPLs). Some papers within this topic also assessed the knowledge and support for the NS among consumers and stakeholders, with mixed results according to the country where the study was based. For example, in Italy, the awareness of the NS among medical professionals is low [40], while other stakeholders are against its adoption [10]. Conversely, in France, a good amount of support is present for this label [10], while its knowledge increased over time [41].

The assessment of the knowledge and understanding of NS and FOPLs is brought to a further level in "Impact of FOP labels on healthy choices" (15.6%) and "Nutritional evaluation and environmental impact of food products" (7.4%). In both topics, in fact, the focus shifts to the impacts of NS and similar labels on food choices, thus investigating how these labels can actually modify the purchase behaviour of consumers. The former topic is characterized by the specific evaluation of the NS label while, when multiple labels are considered, this is performed

in a more comparative flavour. Most of the studies associated with this topic found positive effects of the NS on the healthiness of actual purchases [42–44]. A recurrent finding, however, is that NS succeeds in increasing the purchase of healthy products, but it does not alter the purchase of unhealthy ones [45–48]. Studies related to the latter topic, on the other hand, tend to assess the effect of multiple labels when added together in the same product. The NS seems not to lose its effectiveness in promoting healthier food choices when other quality labels are displayed on the product [11,49,50].

While the NS is meant to drive healthier food choices, the ultimate goal is to improve, through these choices, the health of individuals. In this respect, studies focusing on "Medical aspects" (9.7%) assess whether healthy diets (where healthiness is defined ac-cording to the NS) have positive impacts on several health aspects and diseases, finding associated reductions in long-term mortality [51], kidney function decline [52], or obesity [53], among others.

A couple of the identified topics have a more technical flavour, focusing mainly on the algorithm used to obtain the NS. One of them, "Assessment of NS performance and adherence with dietary guidelines" is related to studies that verify how the NS classification performs when contrasted with specific diets. In this respect, the NS has been found to be in line with the Mediterranean diet [54], and with the Dutch, German, and Slovenian dietary guidelines [55–57]. Other studies verified the ability of the NS algorithm to effectively discriminate foods according to their nutritional quality [58,59]. In addition, some of the exemplary papers within this topic also suggest some improvements to the NS algorithm to also consider the presence of specific ingredients, such as nuts [60] or whole grains [61]. The comparison of the NS algorithm with other nutrient profiling systems is an issue addressed within the "Different nutrient profiling systems topic" (7.5% of the corpus). Studies focusing on this topic usually utilize a reference system to validate one or more alternative systems [62], while they often identify some discrepancies between the ratings obtained using different FOPLs [63,64].

A final class of topics is the one where the NS is not of interest *per se*, but is merely used as a tool to measure the nutritional quality of food products. Within these topics, therefore, the objective is the nutritional evaluation of specific products, despite slightly different perspectives possibly being adopted. The "Advertisements drive unhealthy food choices" (9.5%) topic focuses on the valuation of advertised products. Most of these studies observe that there is some association between the low nutritional quality of products and the advertisement discourses and strategies [65–67], while several studies estimated advertised products intended for children and younger generations to be of low nutritional quality [68–

70]. The level of processing of food products and its relevance for nutritional quality is explored in the "NS and ultra-processed foods" (6.5%). Also in this case, the NS is used to assess the nutritional quality of products. In this respect, a couple of studies [71,72] found that there is no relation between the level of food processing and the NS grade (the NS was indeed devised to just communicate nutritional quality). Finally, the topic "Assessment of nutritional quality of food through NS" (8.0%) is more general in nature, mainly evaluating the nutritional quality of specific products (especially innovative ones, like in [73] or in [74]), or of whole food baskets [75] and meals [76].

3.4. Discussion

The results illustrated in the previous section highlight that the NS debate moves along some broad common paths in the four considered countries, but that national specificities do also exist, either in the way these paths are addressed or in the presence of specific aspects of interest. Figure 8 provides a possible classification of the identified national topics, which aims at facilitating critical discussion and considerations, without being meant to be a conclusive one.

In every country, people talk about the adoption of the NS in their homeland as in other EU countries, as shown in Figure 3.9, which reports the prevalence of the clusters defined in Figure 3.8 over time (obtained aggregating the individual topics' prevalence). Discussions about "NS adoption" were in fact a hot topic when France (2017) and Belgium (2018) decided to give legal recognition to this FOPL and the EU envisaged, within the F2F strategy, a possible mandatory use of the NS on pre-packed food. Afterwards, the interest in the NS-adoption subject declined, with the exception of Spain, where the three years that elapsed between the first government proposal (in 2018) and the final NS adoption (in 2021) likely sustained the debate.

The role of national governments in the issue inevitably brings "Politics" to the fore. Apart from France, where the final NS adoption in 2017 might have somewhat settled the merely political debate, in the other three countries, discussions characterized by an intense political flavor recursively appeared. While the specific themes of these discussions clearly have a strong national component, the general sentiment transpiring from them is also quite diverse in the three contexts. In Italy, where the target of this kind of tweet is individuals supporting the NS in the national political arena and, most often, EU institutions, a strong opposition to the

NS system is advocated. A negative attitude is also present in the Spanish tweets, despite the main target being the national government, especially after some of its members revealed some inconsistencies in their stance about the NS topic. Conversely, the critics of the federal government in Germany argue in the opposite direction, asking for a more active role of the government in the adoption of the NS tool.

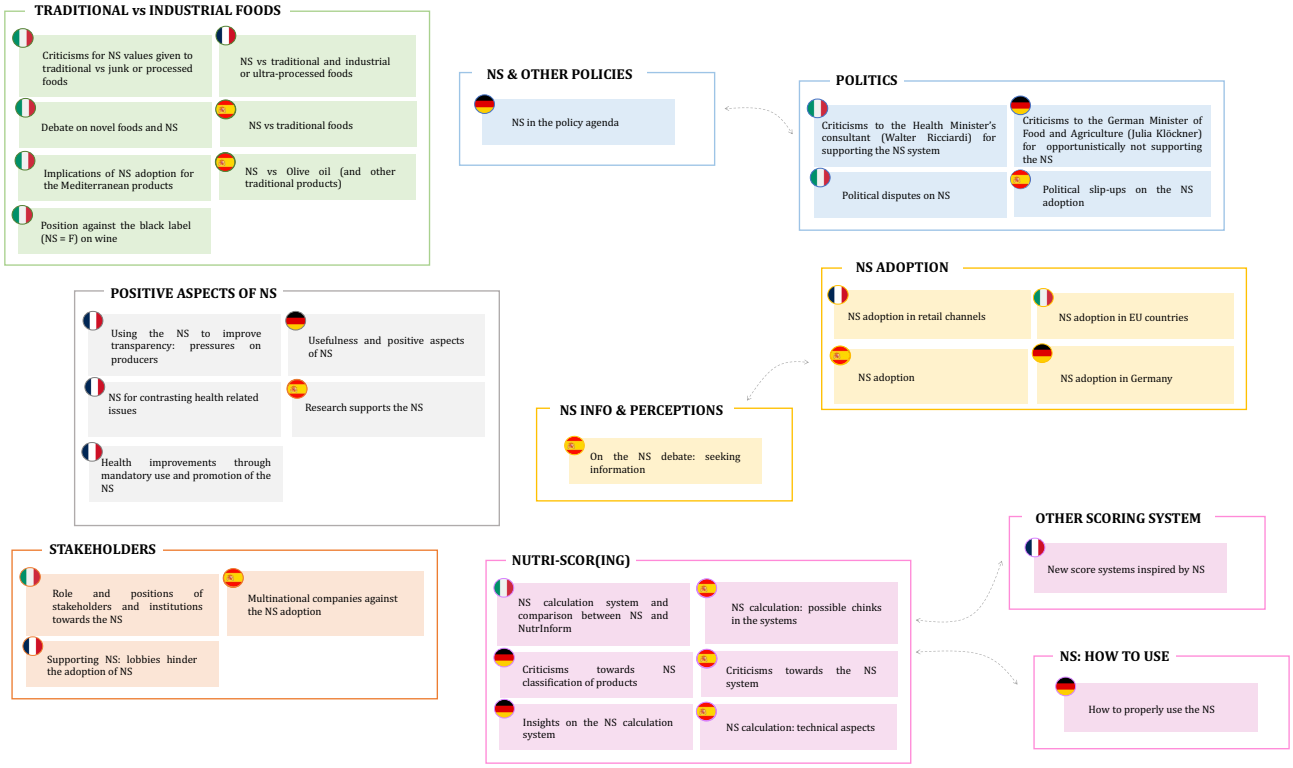

Figure 3.8. Classification of the national Twitter topics according to their content

A similar heterogeneity in approaching a common theme is found when the discussion is about "Stakeholders". In Italy, again, various types of people linked to the food sector (e.g., professional associations, consortia, producers' organizations) express their disagreement with the NS system, trying to prevent its adoption at the national level. On the opposite side, the discourse in France and Spain is usually directed towards a critique of large companies resisting the NS, in an attempt to press them to use the tool to promote a more transparent food system.

Transparency, indeed, is considered one of the "Positive aspects" of NS, which is claimed to allow consumers to make informed choices. Looking on the bright side is more common in countries that have already issued an NS legislation (France, Germany, and Spain), while it is rarely done in Italy. Whether the acknowledgment of the NS positive aspects by the

general public is a cause or an effect of the national adoption of the system might be an interesting question to address in future research.

France is the country where the positive aspects have been stressed the most, but Figure 9 shows that they lost some importance in recent years, especially to the benefit of debates on "Traditional vs. industrial foods". The relation between NS and traditional products mainly interests the three Mediterranean countries (France, Italy, and Spain) and, as for the specific French case, has tended to increase in the last few years. The attention to this issue is likely to be related to the strong importance in these countries of geographical indications (GIs). On the one hand, the presence of GIs has been considered an indicator of a food culture strongly based on traditions and traditional products [77]. In addition, some of the largest GIs in these countries, which are mainly related to the meat, cheese, and olive oil sectors, will likely be negatively affected by the introduction of the NS [11]. While in France and Spain, the discussion is mostly concerned with the NS classification of GI and other traditional products, the Italian debate goes further. Indeed, Italian users seem to place the NS within a broader conflict between national culinary habits and traditions and novel, foreign, and "artificial" foods that risk replacing the local food culture.

While these arguments are characterized by a strong identitarian component, criticisms of the NS are also put forward in a less ideological way, for example by looking at the potential flaws in the NS algorithm. These kinds of discussions, which are grouped in the "Nutri-scor(ing)" cluster, appear in Italy, where the main concern seems to be the comparison with the Italian-proposed nutritional label (i.e., Nutrinform), as well as in Germany and Spain, where their importance is growing. Interestingly, in the latter countries, some debates are observed that denote a good knowledge of the topic, and also its technical aspects. Specifically, issues are mentioned such as the need to account, in the nutritional evaluation of food, for the size of the portions and the composition of the whole meal, as well as the importance in limiting the use of the NS for comparing products within the same food category.

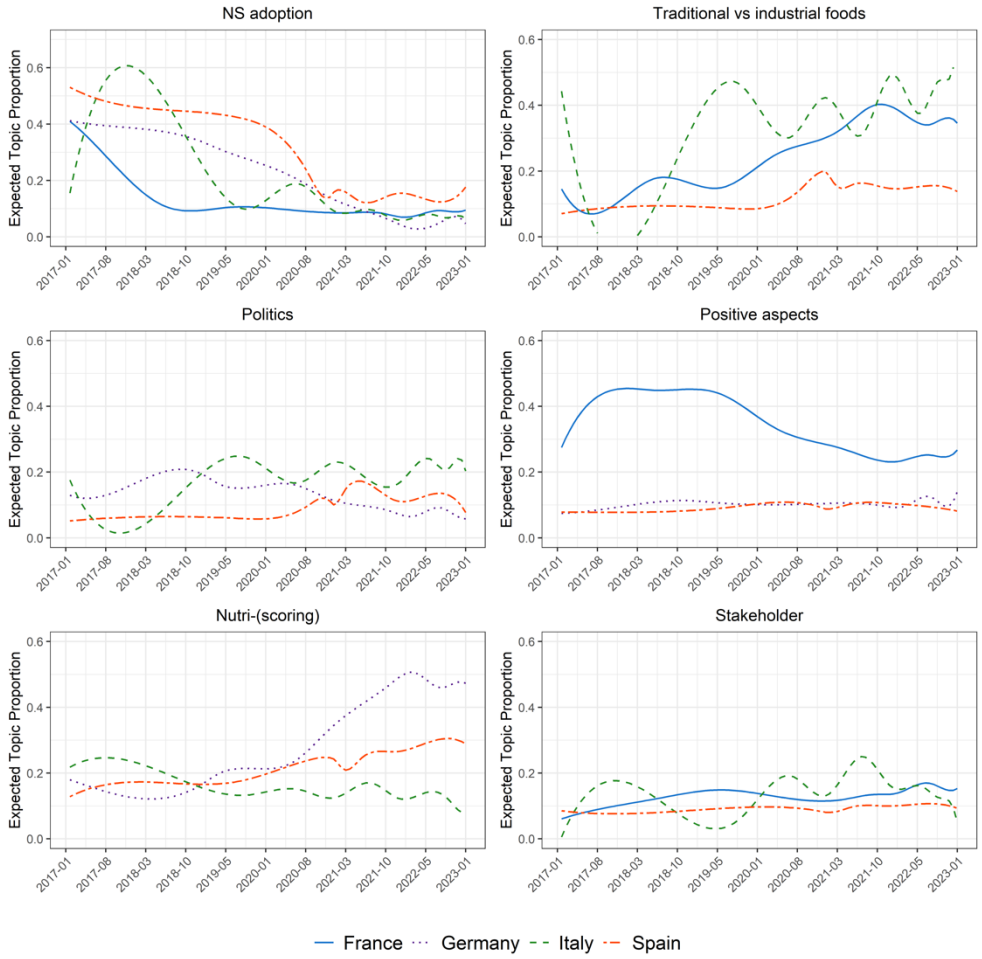

Figure 3.9. Estimated temporal trends of topic clusters by country

Comparing Science and Society

Given the diversified issues raised in the four considered countries, a clear need emerged to understand the extent to which the scientific community has addressed the aspects that stemmed from the public debate. Indeed, to decide what FOPL to adopt at the EU level, the European Commission needs to have a complete overview of the NS topic, evaluating all its technical features while considering, at the same time, the most relevant issues raised by citizens and politics. To this extent, in Figure 10, all the topics that emerged from the literature analysis are placed side by side those retrieved from tweets (Figure 3.8) to display in a clear way the similarities and differences between the scientific and the public debate.

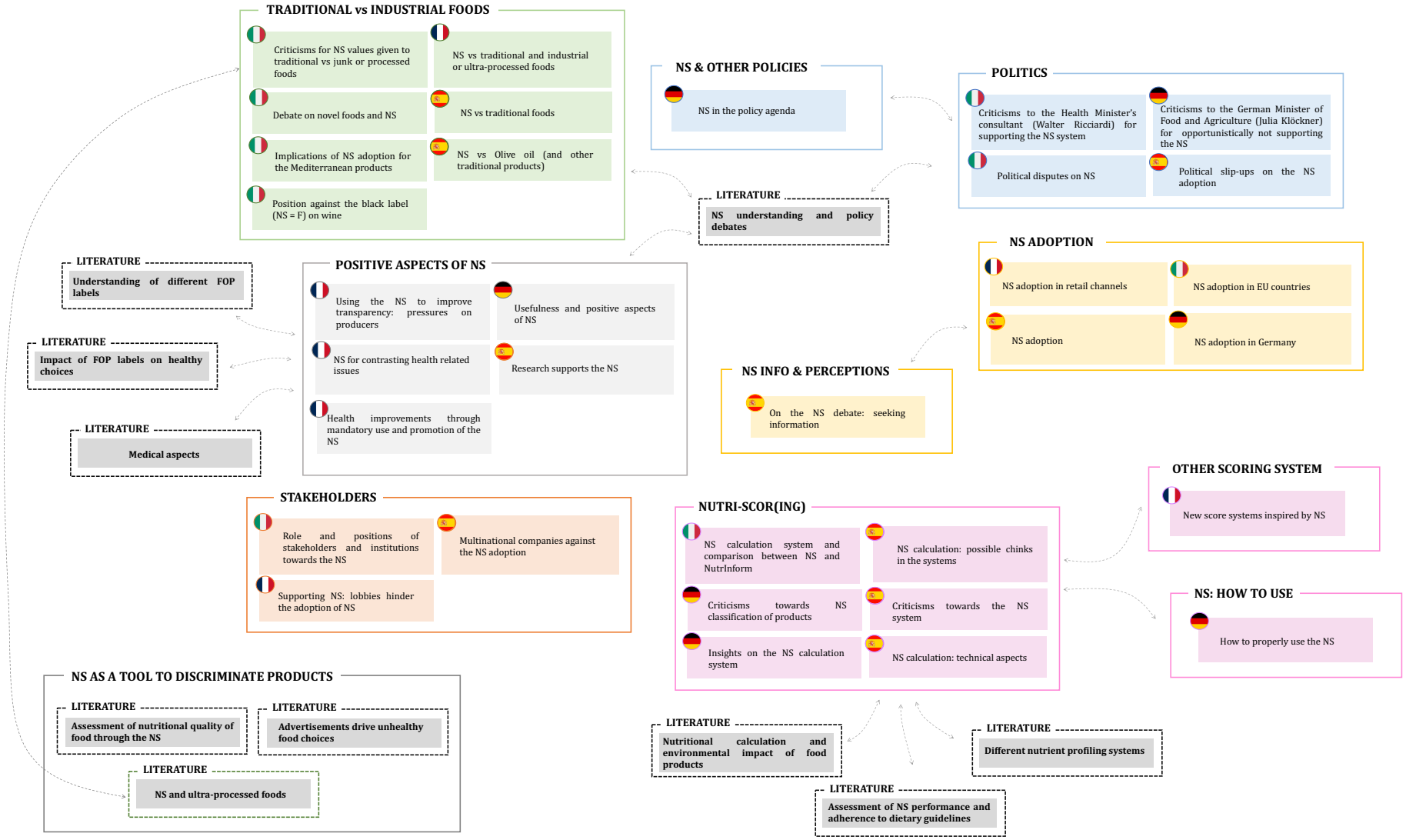

Figure 3.10. Comparison between the topics emerged from the scientific literature (grey squared; dotted line) and tweets on the NS label

As shown in Figure 3.10, not all the main topics discussed at a political and societal level are addressed by researchers, as some Twitter topics appear not to be related to the scientific ones. Unsurprisingly, the "NS adoption" topic finds no corresponding interest at the scientific level, as it is not a meaningful aim of scientific research. Indeed, even if most of the papers deal with NS adoption (e.g., [6,78]), describing, in different countries, how and when various FOPLs (including NS) were adopted at the European level, this is never considered the primary aim of these papers. On the contrary, extensive correspondence is found when considering the "Positive aspects" associated with NS adoption. As widely discussed in many papers ("Understanding of different FOP labels"), the NS has been strongly supported at the European level, being considered one of the easiest-to-understand FOPLs [6,79]. Providing simple information about the nutritional content of foods, and thus reducing the information asymmetry, NS seems to guide consumers towards healthier choices, as widely described in the literature topic "Impact of FOP labels" [80,81]. Choosing the healthiest products turns, inevitably, into a virtuous cycle, whereby diet-related diseases, such as obesity, renal diseases, and cancer, seem to (potentially) decrease in patients using NS [52,82], as described in the "Medical aspects" papers.

Despite these promising premises, however, the literature lacks in analysis of how this label might impact the market dynamics, both on the producers' and consumers' side. Twitter analysis has indeed highlighted a general reluctance of some food industries to adopt the NS ("Stakeholders"), although no matching topic was found in the literature. Indeed, only one paper [10] deals with this aspect, underlining how Italian stakeholders question the NS effectiveness on multiple levels: cognitive, normative, and political. At the political level, much attention has been paid to this issue, stressing the possible negative effect that this labeling could have on some products (or product categories). This is especially true for GI products, which cannot be easily reformulated, as is the case for the industrial ones, due to their product specification. This aspect, while much debated on the web ("Traditional vs. industrial foods"), has only been considered by a handful of articles [10,11].

The same does not apply to the relationship between ultra-processed products and NS, largely criticized by consumers and politicians. Indeed, different ultra-processed products are considered as the healthiest option (NS equal to "A" or, at least, "B") by the NS algorithm, even if the consumption of Ultra-Processed Foods (UPFs) has been associated with low diet quality, obesity, and adverse health effects [83]. The literature partially addresses this issue, even if, in

most of the cases, the NS has been used as a tool to discriminate products according to their nutritional profile rather than considering the NS as the main topic of the research (e.g., [83–85]). However, several authors, such as Valenzuela et al. [63] or Romero Ferreiro et al. [86], have addressed this issue, highlighting some discrepancies within the two labeling systems. The calculation mechanism behind the NS has been, in fact, strongly criticized by Twitter users in several countries, as suggested by the topics reported in the "Nutri-Scor(ing)" cluster. From the scientific side, some improvements to the algorithm have been proposed, such as including nuts [60] or whole grains [61] as positive elements, to better follow the path of healthy eating.

In line with this aspect, a general disappointment also emerges when considering the NS evaluation of the Mediterranean diet products ("Assessment of NS performance and adherence with dietary guidelines"*)*. According to some Twitter users, the algorithm, in fact, seemed to "damage" some of these products. However, as explained by Vlassopoulos et al. [54], the NS is perfectly in line with the Mediterranean diet, as products of animal origin, evaluated negatively by the NS, are also considered products to be consumed with limitations from the Mediterranean diet precepts. This opens up an important food for thought. In most scientific papers, in fact, products with NS "D" or "E" are generally considered as "unhealthy" products, while the NS guidelines (at least in the latest version) define sugars, fatty acids, calories, and salt as elements and ingredients "to be limited in consumption", which does not imply a totally negative evaluation of the product itself, but simply an indication of use. In light of what emerged from the analysis of the tweets and of the literature, it is, however, clear that this difference is not clearly understood by consumers and, probably, should be better clarified to make the label truly effective. Indeed, as discussed by Stiletto and Trestini [11], in countries unfamiliar with the NS, such as Italy, consumers with a low awareness of the label evaluate it as an element of product quality, regardless of the score assigned to it. This means that for the NS to be effective, supplementary information on what the NS is and how it works should be provided, using words and systems understandable in all EU countries. At the same time, studies aimed at determining the effectiveness of NSs in guiding consumers' food choices should be conducted in all EU countries, considering that familiarity with the label is one of the main factors affecting its efficacy [5]

This study is subject to some limitations. First, it should be considered that a Twitter text is quite short, potentially affecting the ability to express viewpoints in a clear way. Second, we used Twitter as the only data source to ascertain public opinion on the NS, while other social

media or grey literature could also be potentially used to reach this objective. In addition, it must be kept in mind that Twitter users (as in the case of social media in general) might not be representative of the whole population [19]. In this respect, further studies will be useful to extend the scope of this analysis to segments of the population that are at risk of being underrepresented in a social media context. Finally, this study lacks a comparison between the Twitter and literature trends. However, this limitation, which is essentially due to the novelty of the NS topic, will be easily addressed in a few years, when a wider series of published scientific material on NS will be available.

3.5. Conclusions

Our study stressed that the NS debate is relevant and heterogeneous across Europe. At the EU institutional level, NS benefits from a quite large amount of support, being considered the most effective FOPL in guiding consumers' choices towards healthier food products. This view is substantiated by several scientific studies, which proved that NS actually promotes healthier food choices, while performing better than other FOPLs.

Despite this evidence, however, consumers and policy makers all over Europe have pointed out some critical issues related to the use of the label that, if not adequately addressed, could undermine its effectiveness in the long run. Among others, the (potential) negative effect of NS on some products (such as traditional products) is the most mentioned one, especially in Mediterranean countries. In addition, some inconsistencies in the calculation system are brought to attention, as well as some criticalities concerning the correct interpretation of the label.

To help settle this debate and address the concerns raised by consumers and stakeholders, further research is needed. Specifically, new literature on the topic can play a twofold role, based on the results that will emerge from future studies. On the one hand, scientific research outcomes, if properly communicated, can reassure the public opinion on issues and concerns that turn out to be unfounded. On the other hand, if the existence of some flaws in the NS is actually proved, tailored research can serve as the basis on which to improve the NS tool. With respect to the latter aspect, this has already happened, for example, in the case of olive oil and nuts, whose original misclassification led to a revision in the NS algorithm.

Widening the NS research to explore the concerns and issues raised by society has

therefore the potential to facilitate policy decisions. In fact, while it would be unreasonable to imagine the removal of any critique, having a complete vision of the NS topic derived from research might allow the legislator to justify the final decision (whichever it will be) on a more solid ground.

However, it should also be acknowledged that scientific research alone might not be enough. Our analysis showed that several criticisms of the NS system stem from a misinterpretation of the label. This evidence suggests that any policy decision on the issue should be accompanied by communication activities aimed at informing consumers and stakeholders about what the NS is, how it works, and how to properly use it. Otherwise, paradoxically, a tool created to reduce information asymmetry seems instead to be a slave to it. For example, explaining that NS suggests the recommended consumption dose of a product and does not classify it as "healthy" or "unhealthy" would contribute to alleviating some of the distrust towards this label. At the same time, creating information campaigns related to the correct use of the label, so that it is also useful to those consumers who are unfamiliar with the NS and may therefore misinterpret it, might be the best way to increase the label's effectiveness and reach its intended outcome, namely reducing the rate of obesity and overweight in Europe.

Further research should analyze the impact of the Nutri-Score on the market dynamics, from both a producers' and consumers' side, especially considering Traditional Foods, such as Geographical Indications. In addition, as the NS topic is not equally investigated in all the European Countries (although it is an EU policy), NS consumers' understanding should be investigated in all the European countries, especially in those with low familiarity with the label.

Appendix 3.A

Table A3.1. Topics identified in the Twitter corpus

Topic	Most Typical Terms	Prevalence	Exemplary Tweets (Native Language)	Exemplary Tweets (English Translation)
			ITALY	
T1 Debate on novel foods and NS	eat nothing good sense read grasshoppers worms synthetic dish want	11.1%	L'UE sta disintegrando il nostro vivere millenario, vuol farci mangiare insetti che contengono questi parassiti e mette il NUTRISCORE più alto su coca cola che non il Parmigiano Reggiano!	The EU is disintegrating our millenary life, it wants us to eat insects that contain these parasites and puts the highest NUTRISCORE on coca cola than Parmigiano Reggiano!
			🛑 IL PARADOSSO UE: GLI INSETTI SÌ, IL PARMIGIANO NO! Prima con il Nutriscore l'UE mette in discussione i nostri prodotti bandiera (Parmigiano, olio d'oliva, ecc) e poi dà l'ok a farci mangiare insetti e larve? A voi i commenti…	🛑 THE EU PARADOX: INSECTS YES, PARMIGIANO NO! First with the Nutriscore, the EU questions our flagship products (Parmesan, olive oil, etc) and then gives the ok to let us eat insects and larvae? To you the comments…
			L'Europa non ci costringe a mangiare insetti e bere vino annacquato. Il Nutriscore è uno strumento di valutazione sulla salubrità del cibo, nessuno ci obbliga a seguirlo. Mangiamo già insetti, una minima parte è tollerata dalla legge perché facentes parte del processo produttivo	Europe does not force us to eat insects and drink watered wine. The Nutriscore is an assessment tool on the wholesomeness of food, nobody forces us to follow it. We already eat insects. A small part is tolerated by law because it is part of the production process.
T2 Role and position of Stakeholders and Institutions towards NS	Patuanelli legal protection president supply chain Confargicoltura antitrust PGI Federalimentare future interview	13.9%	Continua il dibattito sul Nutriscore, Asti Agricoltura: "Confidiamo nel Governo affinché tuteli l'intera filiera agroalimentare italiana	The debate on Nutriscore is still going, Asti Agricoltura: "We trust the Government to protect the entire Italian agri-food chain
			@origin_italia ha incontrato il Ministro @SPatuanelli: al centro dell'incontro la Riforma del sistema delle #DOP #IGP, il #Nutriscore, i contratti di filiera per il #PNRR e la nuova #PAC	@origin_italia met the Minister @SPatuanelli: the Reform of the #PDO #IGP system, the #Nutriscore, the supply chain contracts for the #PNRR and the new #CAP were at the center of the meeting
			#Draghi sul #Nutriscore alla Camera dei Deputati: "Il Governo è totalmente consapevole della gravità che l'introduzione del Nutriscore può costituire per la nostra filiera produttiva agroalimentare e pienamente impegnato nella sua tutela"	#Draghi on the #Nutriscore in the Chamber of Deputies: "The Government is fully aware of the gravity that the introduction of the Nutriscore can represent for our agri-food production chain and fully committed to its protection"
T3 Political disputes on NS	Italians Meloni politics *green*	10.2%	Giorgia Meloni, porcheria Nutri- Score: "Von der Leyen, dovrai passare sopra il mio corpo"	Giorgia Meloni, Nutri-Score filth: "Von der Leyen, you will have to go over my body"
			Vittorio Feltri distrugge l'Europa sulla certificazione dei cibi: "Imbecillità totale". Non sono imbecilli in UE,	Vittorio Feltri destroys Europe on food certification: "Total imbecility". They are not imbeciles in the EU,

	Lollobrigida approved agenda very *sound* hands		perseguono il loro obiettivo primario..rendere l'Italia una nazione povera, sotto controllo dell'UE…	they pursue their primary goal.. to make Italy a poor nation, under the EU control…
			Ahhh le menzogne traditori sono talmente divertenti per i soliti pecoroni!I PiDioti hanno approvato il Nutriscore in Europa che ammazza i nostri prodotti e le nostre imprese! Hanno approvato l'agenda green che ammazza la nostra industria automobilistica! Il PD distrugge l'Italia	Ahhh the treacherous lies are so much fun for the usual idiots! The (PD)idiots have approved the Nutriscore in Europe which kills our products and our businesses! They approved the green agenda that is killing our car industry! The PD destroys Italy
T4 Implications of NS adoption for Mediterranean products	*Made* *Italy* food Italian Mediterranean attack risk *export* synthetic threat	9.3%	Nutriscore, ora il Made in Italy trema davvero	Nutriscore, now Made in Italy is really trembling
			Made in Italy, Coldiretti: il via libera all'etichetta Nutriscore che rischia di espandersi a livello globale mette in pericolo il record di 46,1 miliardi di esportazioni agroalimentari tricolori del 2020	Made in Italy, Coldiretti: green light for the Nutriscore label which risks expanding globally endangers the record of 46.1 billion in Italian agri-food exports in 2020
			#G20, Coldiretti: omaggiare i grandi della Terra con vino o olio non è solo un'importante azione di promozione del cibo Made in Italy all'estero ma anche un preciso segnale politico a difesa della dieta mediterranea sotto attacco del Nutriscore e delle etichette allarmistiche	#G20, Coldiretti: paying homage to the greats of the Earth with wine or oil is not only an important action to promote Made in Italy food abroad but also a precise political signal in defense of the Mediterranean diet under attack by Nutriscore and labels alarmist
T5 NS adoption in EU Countries	Italy label Germany same *Fratelli* adopted Belgium category against adopt	9.5%	Belgio: #Carrefour e #Danone adottano il #NutriScore. Arriverà prima su app e web, ed entro il 2020 sulle confezioni	Belgium: #Carrefour and #Danone adopt the #NutriScore. It will arrive first on the app and web, and by 2020 on packaging.
			Nutri-Score: anche la Spagna adotta l'etichetta a semaforo francese	Nutri-Score: Spain also adopts the French traffic light label
			Il Nutri-Score arriva anche in Italia! L'etichetta a semaforo su un prodotto Sojasun comprato da #Lidl #NutriScore #etichettaSemaforo #nutrizione #Sojasun	The Nutri-Score also arrives in Italy! The traffic light label on a Sojasun product bought from #Lidl #NutriScore #labelSemaforo #nutrizione #Sojasun
T6 Position against the black label (NS = F) on wine	understanded black nobody to understand beverages indeed never still cancer *propaganda*	13.5%	La @Federcuochi risponde con fermezza NO all'ennesima folle proposta degli ideatori del Nutriscore, che vorrebbero etichettare con una F nera tutte le bevande contenenti anche una minima percentuale alcolica.	The @Federcuochi firmly replies NO to the umpteenth crazy proposal from the creators of Nutriscore, who would like to label all drinks containing even a minimal percentage of alcohol with a black F.
			"Stupore e sconcerto" per il tentativo di applicare il #Nutriscore a vino e a bevande alcoliche, attribuendo a esse la lettera F di colore nero. Le dichiarazioni di @sweetlemongal e #AlbieraAntinori che esprimono la contrarietà di #Federvini e del comparto	"Amaze and bewilderment" for the attempt to apply the #Nutriscore to wine and alcoholic beverages, attributing to them the black letter F. The statements by @sweetlemongal and #AlbieraAntinori expressing the opposition of #Federvini and the sector

			Zottis (Pd): “#alcolici, nessun bollino nero sulle bottiglie, il vino non è cancerogeno. Vince la chiarezza, sconfitto l’allarmismo” #Nutriscore @ZottisFrancesca	Zottis (Pd): “#alcoholics, no black label on the bottles, wine is not carcinogenic. Clarity wins, scaremongering defeated” #Nutriscore @ZottisFrancesca”
T7 NS calculation system and comparison between NS and Nutrinform	consumers nutritional consumer Nutrinform battery information values choices correct algorithm alternative	13.2%	Il #Nutriscore si basa su un algoritmo che classifica l’alimento in base a zuccheri grassi e sale e non tiene conto dei processi di trasformazione del prodotto (una lasagna confezionata risulta più salutare di un cucchiaino di miele) penalizzando #madeinitaly e #dietamediterranea	The #Nutriscore is based on an algorithm that classifies the food according to fat sugars and salt and does not take into account the transformation processes of the product (a packaged lasagna is healthier than a teaspoon of honey) penalizing #madeinitaly and #Mediterranean diet
			Il Nutri-Score utilizza un algoritmo che tiene conto del contenuto di componenti negativi (energia, grassi saturi, zucchero e sodio) e positivi (fibra, frutta/verdura/oli e, alcune volte, proteine) in 100 g di prodotto	The Nutri-Score uses an algorithm that takes into account the content of negative (energy, saturated fat, sugar and sodium) and positive (fiber, fruit/vegetables/oils and, sometimes, protein) components in 100 g of product
			#Nutriscore crea una dipendenza nel consumatore che deve accettare le valutazioni dell’algoritmo senza comprenderne ragioni. #Nutrinform informa, senza interpretare, fornendo gli elementi per scegliere consapevolmente.	#Nutriscore creates an addiction in the consumer who must accept the evaluations of the algorithm without understanding reasons. #Nutrinform informs, without interpreting, providing the elements to make an informed choice.
T8 Criticism of the Health Minister’s consultant (Walter Ricciardi) for supporting the NS system	Italians Ricciardi in favor Speranza penalize damage scientists signed Walter consultant	10.6%	Ricciardi a favore del Nutriscore, scoppia il caso nel Governo. Salvini: “Si dimetta” Tutti contro Ricciardi, ma è uno scienziato (uno dei 280 firmatari dell’appello) e difende la salute, non gli interessi economici delle aziende.	Ricciardi in favor of the Nutriscore, the case breaks out in the Government. Salvini: “He should resign” All against Ricciardi, but he is a scientist (one of the 280 signatories of the petition) and defends health, not the economic interests of companies.
			🔴🔴🔴🔴… IL NOSTRO È L’UNICO PAESE AL MONDO GOVERNATO DAI SUOI NEMICI. RICCIARDI SI DIMETTA!	🔴🔴🔴🔴… OURS IS THE ONLY COUNTRY IN THE WORLD GOVERNED BY ITS OWN ENEMIES. RICCIARDI MUST RESIGN!
			🔴 Walter Ricciardi, super consulente di Speranza, si è di fatto schierato a favore dell’introduzione in Europa del #Nutriscore, il sistema di etichettatura fortemente voluto dai francesi che penalizza i prodotti italiani	🔴 Walter Ricciardi, super consultant of Speranza, has in fact sided in favor of the introduction in Europe of the #Nutriscore, the labeling system strongly desired by the French which penalizes Italian products
T9 Criticism for NS values given to traditional vs. junk or processed foods	(olive) oil Parmigiano olive red ham coca green cola	8.6%	Secondo il #Nutriscore voluto dall’UE, l’olio extra vergine di oliva merita il bollino rosso e la Coca Cola zero il semaforo verde… no comment.	According to the #Nutriscore, supported by the EU, extra virgin olive oil deserves the red label and Coca Cola zero the green light… no comment.
			Grazie al Nutri-score avremo una Mozzarella di Bufala Campana DOP, lavorata a mano, segnalata come più pericolosa per la salute rispetto ad una bistecca di soia estrusa a macchina ed aromatizzata con insaporiti chimici!	Thanks to the Nutri-score we will have a Mozzarella di Bufala Campana PDO, hand-crafted, considered as more dangerous to health than a machine-extruded soybean steak flavored with chemical flavorings!

	Reggiano fries		In #Francia l'hamburger ai fast food risulta più "sano" del prosciutto di Parma Dop. E lo stesso vale per l'olio extravergine di oliva e il parmigiano. Ecco svelato a cosa serve il #Nutriscore: uccidere il #MadeinItaly	In #France, fast food hamburgers are healthier than Prosciutto di Parma PDO. And the same goes for extra virgin olive oil and Parmigiano Reggiano PDO. Here's what the #Nutriscore is for: killing #MadeinItaly
			FRANCE	
T1 Health improvements through mandatory use and promotion of the NS	Santè food mandatory information Publique make European choose industry advertising	13.9%	Le Nutri-Score obligatoire dans les publicités des aliments. Les annonceurs pourront cependant y déroger moyennant une contribution affectée à l'Agence nationale de santé publique 🤔 On rend les gens malades, mais on contribue a les soigner…	Nutri-Score (will be) mandatory in food advertisements. Advertisers will however be able to derogate from it by means of a contribution allocated to the National Public Health Agency 🤔 We make people sick, but we help to treat them…
			L'Assemblée nationale a rejeté dimanche un amendement visant à rendre obligatoire dans les publicités audiovisuelles le Nutri-Score, qui indique les vertus alimentaires d'un produit.	The National Assembly on Sunday rejected an amendment aimed at making the Nutri-Score mandatory in audiovisual advertisements, which indicates the nutritional virtues of a product.
			📄 Communiqué de presse | Santé publique France lance la première campagne nationale pour faire connaître le #NutriScore auprès des consommateurs	📄 Press release | Santé publique France launches the first national campaign to promote the #NutriScore to consumers
T2 Supporting NS: lobbies hinder the adoption of NS	how to be little other lobby good been Europe best European	13.2%	Face aux lobbys, 36 associations de professionnels de santé (nutritionnistes, diabétologues, pédiatres, cancérologues, cardiologues, acteurs de santé publique…), consommateurs et patients et ONGs appellent à signer une pétition pour défendre #NutriScore	Faced with lobbies, 36 associations of health professionals (nutritionists, diabetologists, pediatricians, oncologists, cardiologists, public health actors, etc.), consumers and patients and NGOs are calling to sign a petition to defend #NutriScore
			Pour faire changer les choses et rendre obligatoire le #NutriScore au niveau européen, une initiative citoyenne européenne a été lancée pour lutter contre la #malbouffe. Pour la santé publique contre les lobbys qui s'y opposent, SIGNEZ LA PETITION http://pronutriscore.org	To change things and make #NutriScore compulsory at European level, a European citizens' initiative has been launched to fight against #junk food. For public health against the lobbies that oppose it, SIGN THE PETITION http://pronutriscore.org
			Merci @isabellesaporta mais la bataille n'est pas finie. De puissantes multinationales continuer a refuser #Nutriscore: Kelloggs, Ferrero, Mars, Unilever, Mondelez, Coca, Pepsi… Pour leur forcer la main il faut signer en masse la pétition européenne http://pronutriscore.org	Thanks @isabellesaporta but the battle is not over. Powerful multinationals continue to refuse #Nutriscore: Kelloggs, Ferrero, Mars, Unilever, Mondelez, Coca, Pepsi… To force their hand, you have to sign the European petition en masse http://pronutriscore.org
T3 New score systems inspired by the NS	organic have by	15.6%	Visite ce matin de l'entreprise Jacquet-Brossard l'occasion de parler économie sociale et circulaire,	Visit this morning of the Jacquet-Brossard company the opportunity to talk about social and circular economy, organic sectors, nutriscore, integration

	impact recipe idea fruits effect given rated		filières bio, nutriscore, insertion par l'emploi, coopérative @Limagrain @CoopdeFrance @lamontagne_fr @F3Auvergne @FBAuvergne @RCFPuydeDome	through employment, cooperative @Limagrain @CoopdeFrance @lamontagne_fr @F3Auvergne @FBAuvergne @RCFPuydeDome
			Après le NutriScore pour l'alimentation, voilà le CyberScore pour la sécurité des sites. A lire sur @Numerama 📰 "Le texte doit déboucher par la mise en place d'une certification de cybersécurité des plateformes numériques destinée au grand public	After the NutriScore for food, here is the CyberScore for site security. To read on @Numerama 📰 "The text must lead to the establishment of a cybersecurity certification for digital platforms intended for the general public
			Et si un "Nutriscore" de la responsabilité sociale des entreprises voyait le jour, en mesurant une quinzaine d'indicateurs transversaux et structurants sur quatre piliers: l'impact social et environnemental, le partage des richesses et du pouvoir?	What if a "Nutriscore" of corporate social responsibility were created, measuring fifteen cross-cutting and structuring indicators on four pillars: social and environmental impact, sharing of wealth and power?
T4 NS vs. traditional and industrial or ultra-processed foods	good same good note cheese processed score fat few nothing	28.8%	Les producteurs de #Roquefort demandent à être exemptés du #NutriScore. Le fromage au lait de brebis de l'#Aveyron est mal classé, en raison de ses taux de sel et d'acide gras saturé	#Roquefort producers ask to be exempted from #NutriScore. Sheep's milk cheese from #Aveyron is poorly classified, due to its salt and saturated fatty acid levels
			Steak 100% pur boeuf score C Steak de soja score A (ultra transformé a base d'eau, huile, protéine en poudre, et autres additifs)… Depuis que j'ai vu ça j'ignore le nutriscore 😉	Steak 100% pure beef score C Score A soybean steak (ultra-processed with water, oil, protein powder, and other additives)… Since I saw that I ignore the nutriscore 😉
			Tout les fromages (la plupart) ont un Nutriscore degueulasse. Forcément, le fromage c'est quasiment du gras. Et alors? Les gens savent se qu'ils achètent quand ils prennent du fromage. Donc j'ai envie de dire: on s'en fout du nutriscore	All cheeses (most) have a disgusting Nutriscore. Inevitably, cheese is almost fat. So what? People know what they're buying when they get cheese. So I want to say: who cares about the nutriscore
T5 NS adoption in retail chains	do label nutritional logo already used calculation know study engaged	10.4%	Devant Marisol Touraine et la CLCV, Intermarché, Leclerc, Auchan et Fleury Michon s'engagent à utiliser Nutriscore	In front of Marisol Touraine and the CLCV, Intermarché, Leclerc, Auchan and Fleury Michon commit to using Nutriscore
			Un nouveau logo nutritionnel arrive sur les aliments dès avril: le NutriScore	A new nutritional logo is coming to food in April: the Nutri Score
			La nouvelle étiquette #Nutriscore dans nos rayons en avril 🛒 #alimentation #nutrition #sante #food #packaging #info	The new #Nutriscore label on our shelves in April 🛒 #food #nutrition #health #food #packaging #info

T6 Using the NS to improve transparency: pressures on producers	consumer industrial all again labelled choice transparent question point something	10.4%	Nutriscore: Les marques qui l utilisent ont choisi la transparence vis à vis des consommateurs. D autres n ont pas voulu, voire lutté contre… Privilégiez les marques qui l ont adopté ! #santé #prévention #nutriscore @sfsp @santeprevention @MinSoliSante @HercbergS	Nutriscore: The brands that use it have chosen transparency for consumers. Others did not want, even fought against… Choose brands that have adopted it! #health #prevention #nutriscore @sfsp @santeprevention @MinSoliSante @HercbergS
			L'application a le succès qu'elle mérite! Si les consommateurs l'utilisent c'est que ce sont les industriels et les distributeurs qui ne jouent pas la transparence sur leurs produits! A quand la vignette Nutri Score sur tous les emballages ? #malbouffe	The application has the success it deserves! If consumers use it, it is because manufacturers and distributors are not transparent about their products! When will the Nutri Score label be on all packaging? #junk food
			#Nutriscore: « La pression des consommateurs peut faire plier les industriels ».Tribune dans le Parisien Dimanche	#Nutriscore: "Consumer pressure can make manufacturers bend". Tribune in the Parisian Sunday
T7 NS for contrasting health-related issues	food nutritional nutrition Yuka French label according to app public interest	7.7%	Le Nutri-score se révèle le plus efficace pour mesurer la qualité nutritionnelle des aliments. #alimentation #nutrition @veillesante @Anses_frm@AlimentSante @IsabelMalsang @leQdM	The Nutri-score is the most effective way to measure the nutritional quality of foods. #alimentation #nutrition @veillesante @Anses_frm@AlimentSante @IsabelMalsang @leQdM
			Nutri-Score: attention, les aliments mal notés augmentent les risques de cancer	Nutri-Score: attention, poorly rated foods increase the risk of cancer
			Le Nutri-Score a été choisi fin octobre 2017 par la France pour mieux informer les consommateurs sur la qualité nutritionnelle des aliments. Selon une étude, les aliments mal notés par le #NutriScore augmentent le risque de cancer	The Nutri-Score was chosen at the end of October 2017 by France to better inform consumers about the nutritional quality of food. According to a study, foods with low #NutriScore scores increase the risk of cancer
GERMANY				
T1 Criticisms of the German Minister of Food and Agriculture (Julia Klöckner) for opportunistically not supporting the NS	Klöckner food traffic light voluntarily study Julia Mrs finally industrial food industry Minister	12.2%	Das Tanzmarichen der Lobbyisten Kennzeichnung Nutri-Score: Wie Ministerin Klöckner die Lebensmittelampel behindert	The lobbyists' dance Marking Nutri-Score: How Minister Klöckner obstructs the food traffic light
			@foodwatch_de berichtet: Im Streit um die Nährwertkennzeichnung von Lebensmitteln ließ das Ernährungsministerium von Julia Klöckner offenbar eine wissenschaftliche Studie stark umschreiben, die dem Nutri-Score ein gutes Zeugnis ausstellt	@foodwatch_en reports: In the dispute over nutritional labeling of food, Julia Klöckner Ministry of Food apparently had a scientific study heavily rewritten that gives the Nutri-Score a good mark
			@JuliaKloeckner verheimlicht uns eine Studie zur Lebensmittelampel, die dem #Nutriscore offenbar ein gutes Zeugnis ausstellt, und veröffentlicht Monate	@JuliaKloeckner hides from us a study on the food traffic light, which apparently gives the #Nutriscore good marks, and only publishes a revised version

			später nur eine überarbeitete Fassung. Schluss mit der Geheimniskrämerei! Her mit der Ampel-Studie	months later. No more secrecy! Bring on the traffic light study
T2 NS adoption in Germany	nutrition label Germany introduction logo food labeling model France fight stigma opinion poll	17.0%	#nutriscore ist eine französische Erfindung, nicht belgisch :) aber in Frankreich, Belgien, Spanien, Polen, Portugal, Litauen, der Schweiz verwendet: es bewegt sich in Europa!	#nutriscore is a French invention, not Belgian :) but used in France, Belgium, Spain, Poland, Portugal, Lithuania, Switzerland: it's moving in Europe!
			Deutschland sucht sein #Nährwert-Logo. Der klare Favorit des @vzbv: #NutriScore. Die farbliche #Nährwertkennzeichnung erleichtert es Verbrauchern nachweislich gesündere Alternativen auf einen Blick zu erkennen. #ProNutriScore	Germany is looking for its #nutritional value logo. The clear favorite of @vzbv: #NutriScore. The colored #nutrition labeling makes it easier for consumers to identify healthier alternatives at the first glance. #ProNutriScore
			Lebensmittelkennzeichnung: Landgericht Hamburg stoppt Nutri-Score vorübergehend: Hamburg—Das Landgericht Hamburg hat eine einstweilige Verfügung gegen die Kennzeichnung von Iglo-Verpackungen mit dem Nutriscore… #NutriScore #BMEL #Klckner #BLL #iglo	Food labeling: Hamburg district court temporarily stops Nutri-Score: Hamburg—The Hamburg district court has issued an injunction against the labeling of Iglo packaging with the NutriScore #NutriScore #BMEL #Klckner #BLL #iglo
T3 Criticisms towards NS classification of products	just fries know bad find on it compare vegan seen cheese	23.8%	HAB GESEHEN DAS MEINE LIEBLINGS HARFER KEKSE NUTRI SCORE E HABEN UND ICH WAR SO ERSCHÜTTERT??? ich dachte die wären eig ganz gesund was soll die scheiße 😭	I SAW MY FAVORITE HARFER BISCUITS HAVE NUTRI SCORE E AND I WAS SO SHOCKED??? I thought they were really healthy, what the heck 😭
			Käse einen Nutri-Score zwischen C und D (hab echt noch nie welchen mit A gesehen) und Nudeln ALLESAMT (egal, ob helle Weizen-, Dinkelvollkorn- oder Kichererbsennudeln) ein A (:	Cheese has a Nutri-Score between C and D (I've really never seen one with an A) and pasta ALL (regardless of whether light wheat, whole meal spelled or chickpea pasta) an A (:
			Die Pommes und das Toastbrot haben Nutriscore A. Und die Pommes sind sogar vegan!! Alles total gesund. Lasst euch nix erzählen!!!!!!	The fries and toast are Nutriscore A. And the fries are even vegan!! Everything totally healthy. Don't let me tell you anything!!!!!!
T4 Usefulness and positive aspects of NS	were people help best shopping right years see read understand	10.5%	Mol ofgesinn vun der willkürlecher Bewertung a dem Choixass dat alles aanescht wei transparent an informativ. Dat kann een normale Konsument net novollzeien, an d'Informatioun iwer den Nutriscore ass net mei einfach ze verstoen wei d'lëscht vun den Inhaltsstoffer	From the point of view of the arbitrary evaluation on the Choixass, everything is transparent and informative. A normal consumer can't accept that the information about the Nutriscore is simply not available because the ingredients are not known
			Nienamd! Und genau deshalb sind vereinfachte Kennzeichnungen wie NutriScore und Co. ja auch eine gute Idee. Weil sie dem Verbraucher auf einen Blick einen Hinweis geben, was er da kauft. Ohne dass er zuvor Oecotrophologie studieren muss.	No man! And that's exactly why simplified labels like NutriScore and Co. are a good idea. Because they give the consumer an indication of what they are buying at a glance. Without having to study ecotrophology beforehand.

			Genuss und Verantwortung @RenateKuenast - bei vielen Lebensmittel wird suggeriert sie wären Grundnahrungsmittel—Verbrauchernnen haben das Recht zu erfahren, was drinsteckt #NutriScore—viel Beifall auf #zeitauftrag @ZEITvst	Enjoyment and responsibility @RenateKuenast—with many foods it is suggested that they are staple foods—consumers have the right to know what's in them #NutriScore—much applause on #zeitauftrag" @ZEITvst
T5 NS in the policy agenda	Nestlé come our year theme November Federal Council companies free Corona	11.8%	Die Politik hat die Aufgabe esellschaftliche Missstände zu regeln. Was für die @cducsubt aktuell keiner Regelung bedarf? -126.000 Küken im Schredder jeden Tag -Kastenstände +17 Jahre -Nutriscore and Tierhaltungslabel nur freiwillig -Bodenversalzung durch Gülle -Profit vor Ethik	Politics has the task of regulating social ills. What for the @cducsubt currently needs no regulation? -126,000 chicks in the shredder every day -Cage stalls +17 years -Nutriscore and livestock label only voluntary -Salting of soil by manure -Profit before ethics
			November 2020: Das ändert sich in Deutschland, Neue Quarantäne-Regelungen, Berliner Flughafen BER, der Nutri-Score und Änderungen bei der Kfz-Steuer—es gib neue Gesetze und Regelungen im November 2020 in Deutschland	November 2020: This changes in Germany, New quarantine regulations, Berlin Airport BER, the Nutri-Score and changes in the motor vehicle tax—there are new laws and regulations in November 2020 in Germany
			Ca. 150k Tote werden jährlich durch falsche Ernährung verursacht und den Nutri-Score verhindert unsere Regierung mit großer Leidenschaft. Wir tragen die Entscheidungen i.S. Corona ja komplett mit, aber beim Thema Ernährung fehlt diese Entschlossenheit. :(	About 150k deaths are caused annually by improper nutrition and the Nutri-Score is prevented by our government with great passion. We support the decisions about Coronavirus completely, but on the subject of nutrition this determination is missing. :(
T6 Insights into the NS calculation system	goes correct healthy declarations nutrition interest opinion meet unhealthy week	9.9%	Verwässern bedeutet verbessern?—Wie mit dem Nutri-Score getrickst wird sup.—Ein Versehen? Oder ein Fehler im System? #Ernährungsexperten wundern sich über die system—#DetlefBrendel #NutriScore #PlassenVerlag #SchlussMitEssverboten	Dilute means improve?—How to cheat with the Nutri-Score for improving it—A mistake? Or a bug in the system? #Nutrition experts wonder about the system…—#DetlefBrendel #NutriScore #PlassenVerlag #SchlossMitEssbanen
			Vorschlag: den intuitiv und schnell verständlichen Nutri-Score (der zudem in Studien getestet ist und sich etwa in Frankreich bewährt hat) auf die Vorderseite, detaillierte Angaben für alle, die es genauer wissen oder angeben möchten, auf die Rückseite	Suggestion: the intuitive and easy-to-understand Nutri-Score (which has also been tested in studies and has been proven in France, for example) on the front, detailed information for anyone who wants to know more or want to specify it on the back.
			Ein führender französischer Ernährungsforscher zum leidigen NUTRISCORE: "…the bases and tenets of this algorithm are debatable and, indeed, much debated...	A leading French nutrition researcher on the vexed NUTRISCORE: "…the bases and tenets of this algorithm are debatable and, indeed, much debated.... the fat

			the fat section of the Nutriscore algorithm is wrong...It is outdated and has no basis…" Genau!	section of the Nutriscore algorithm is wrong...It is outdated and has no basis…" Exactly!
T7 How to properly use the NS	product sugar few make fat actual salt unfortunately example within	14.7%	Mit dem Nutri-Score lassen sich Produkte innerhalb einer Kategorie miteinander vergleichen. Beispielsweise Pizza mit Pizza: Eine Pizza mit „B" hat eine günstigere Nährstoffzusammensetzung als eine Pizza mit „D". Ein Vergleich von Pizza mit TK-Gemüse ist dagegen nicht sinnvoll	The Nutri-Score can be used to compare products within a category. For example, pizza with pizza: A pizza with "B" has a more favorable nutrient composition than a pizza with "D". A comparison of pizza with frozen vegetables, on the other hand, is not meaningful
			Der Nutri-Score nimmt eine Bewertung der Produkte ausschließlich anhand von Nährwerten vor. Die besonderen Anforderungen an Bio-Produkte finden keine Berücksichtigung und ein Vergleich mit konventionellen Produkten ist nur unzureichend möglich	The Nutri-Score evaluates products solely on the basis of nutritional values. The special requirements for organic products are not taken into account and a comparison with conventional products is only barely possible
			wenig, wenn sie einen hohen Gehalt an gesättigten Fettsäuren "kleinrechnen" können in einem einzigen Score. Der Körper verwertet die unterschiedlichen Nährstoffkomplexe und Vitamine/Spurenelemente ja nicht auf zusammengefasste Weise wie ein Nutriscore das suggeriert	It's not enough, if they can "minimize" a high content of saturated fatty acids in a single score. The body does not utilize the different nutrient complexes and vitamins/trace elements in a combined way as a nutriscore suggests
			SPAIN	
T1 On the NS debate: seeking information	diet sector funny company cheese Mediterranean in favor of great important asks	10.5%	El etiquetado NutriScore del PSOE discrimina la dieta mediterránea y podría llegar a afectar a importantes sectores de la empresa murciana, como las conservas, cárnicas y almazaras	The PSOE's NutriScore label discriminates against the Mediterranean diet and could affect important sectors of the Murcian company, such as preserves, meat and oil mills
			Para conocer mejor las bases científicas y las respuestas a críticas fundadas o no sobre Nutri-Score, os aconsejo escuchar la conferencia en el webinar organizada por La Vocalía de Alimentación del Consejo General de Colegios Farmacéuticos de España	To better understand the scientific bases and the responses to criticisms that are founded or not on Nutri-Score, I advise you to listen to the conference in the webinar organized by the Food Committee of the General Council of Pharmaceutical Colleges of Spain
			#RecomiendoLeer Una voz de peso hablando de #Nutriscore que tanta opinión divergente por la comunidad científica ha generado estas semanas Gracias por compartir @RUrrialde_PhD	"#RecommendRead A strong voice talking about #Nutriscore that has generated so much divergent opinion by the scientific community these weeks Thanks for sharing @RUrrialde_PhD
T2 Multinational companies against the NS adoption	good Cola also have	9.0%	Todavia faltan otras Coca-cola, Mars, Ferrero, Mondelez, Unilever… Preguntar por qué no añaden #Nutriscore en sus envases. OCU y CECU continuan la lucha para conseguirlo	Other Coca-Cola, Mars, Ferrero, Mondelez, Unilever are still missing… Ask why they don't add #Nutriscore to their packaging. OCU and CECU continue the fight to achieve it

	made Coca should must still Nestlè		Gracias a la presión de las asociaciones de consumidores, se ha conseguido que grandes empresas, como Nestlé, durante años opuestas a #Nutriscore, lo acepten. Preguntar a Coca, Mars, Ferrero, Mondelez, Unilever por qué todavia no lo añaden en sus envases	Thanks to the pressure of consumer associations, large companies such as Nestlé, for years opposed to #Nutriscore, have been able to accept it. Ask Coca, Mars, Ferrero, Mondelez, Unilever why they still don't add it to their packaging
			Es oficial, Kellogg's adopta #nutriscore !! Todavia faltan otras multinacionales: Unilever, Mars, Coca, Pepsi, Mondelez… les consumidores esperan que adopten nutriscore rapidamente	It's official, Kellogg's adopts #nutriscore !! Other multinationals are still missing: Unilever, Mars, Coke, Pepsi, Mondelez… consumers expect them to quickly adopt nutriscore
T3 Criticisms towards the NS system	to do bad problem to elaborate know negative put can carry change	6.1%	No alcanzan las letras del alfabeto para lo bajo que puntúan en nutriscore unos alfajores te juro qué tristeza	The letters of the alphabet are not enough for the low nutriscore level of some alfajores I swear how sad
			El nutriscore ha sido creado a medida para que las empresas que se dedican a los procesados no salgan mal paradas. Unos Chocapic tienen una B. Es una vergüenza y solo va a servir para que la gente siga comiendo mal	The nutriscore has been created to measure so that companies that are dedicated to processed foods do not go badly off. Some Chocapic have a B. It's a shame and it will only serve to keep people eating badly
			"Nutriscore no entra a valorar si un producto es bueno o malo" Lo que verá el usuario medio: A (verde): bueno E (rojo): malo Y lo saben. Nutriscore = basura Idea original medianamente buena. Ejecución PÉSIMA	Nutriscore does not enter to assess whether a product is good or bad" What the average user will see: A (green): good E (red): bad And they know it. Nutriscore = garbage Moderately good original idea. POOR execution
T4 Research support of the NS	study are major evidence person advertising real thread work interest	9.1%	Casi 60 investigadores de reconocido prestigio firman este interesante artículo. Association between nutritional profiles of foods underlying Nutri-Score front-of-pack labels and mortality: EPIC cohort study in 10 European countries	Almost 60 renowned researchers sign this interesting article. Association between nutritional profiles of foods underlying Nutri-Score front-of-pack labels and mortality: EPIC cohort study in 10 European countries
			Gran estudio europeo (501,000 personas,10 paises y 17 años de seguimiento) publicado en el BMJ que confirma los resultados de otras cohortes y la pertinencia e interés del algoritmo subyacente a #NutriScore por su asociación con la mortalidad y las grandes enfermedades crónicas	Large European study (501,000 people, 10 countries and 17 years of follow-up) published in the BMJ confirming the results of other cohorts and the relevance and interest of the algorithm underlying #NutriScore due to its association with mortality and major chronic diseases
			Estudio. #Nutriscore. Publicado en el BMJ los resultados de un estudio que demuestra que las personas que consumían en promedio más alimentos con menor clasificación por Nutri-Score presentaban un aumento de la mortalidad	Study. #Nutriscore. Published in the BMJ the results of a study that shows that people who consumed on average more foods with lower classification by Nutri-Score had an increase in mortality

T5 Political slip-ups in the NS adoption	only Garzon same (masculine) thing can good category same (feminine) say compare	11.7%	La diputada del PP Carmen Riolobos llama "vendido" a Garzón por implantar Nutriscore… hasta que descubren que ellos mismos lo exigieron	The deputy of the PP Carmen Riolobos calls Garzón "corrupt" for implementing Nutriscore… until they discover that they themselves demanded it
			La banda criminal @populares llama "vendido" a @garzon por implantar @NutriScore… hasta que descubren que ellos mismos lo exigieron	The criminal gang @populares calls " corrupt " @garzon for implementing @NutriScore… until they find out they demanded it themselves
			El lenguaje político actual es bélico: si no estás conmigo, eres un traidor a la patria. Y eso es una absoluta vergüenza. (Al margen de si el etiquetado Nutriscore es bueno o no (aunque se le han visto muchos fallos))	The current political language is warlike: if you are not with me, you are a traitor to the country. And that is an absolute shame. (Regardless of whether Nutriscore labeling is good or not (although many failures have been seen))
T6 NS calculation: possible chinks in the system	to be so here healthy clear day case two places true	7.9%	Respecto a la cuestión planteada sobre la complementariedad entre #NutriScore y ultra-procesamiento leer el documento "Nutri-Score y ultra procesamiento: dos dimensiones diferentes, complementarias y no contradictorias"	Regarding the question raised about the complementarity between #NutriScore and ultra-processing, read the document "Nutri-Score and ultra-processing: two different dimensions, complementary and not contradictory"
			Una lata de fabada contiene aprox. 80 g de chorizo, morcilla, panceta y manteca de cerdo. Por separado cualquiera de esos ingredientes tienen NutriScore E, pero cuando se cocinan junto a las alubias, el resultado es NutriScore A	A tin of fabada contains approx. 80 g of chorizo, black pudding, bacon and lard. Separately, any of those ingredients have NutriScore E, but when cooked together with the beans, the result is NutriScore A
			Me estoy tomando un batido de frutas riquísimo: zumo de piña, plátano, mango, leche de coco, zumo de limón y de repente me fijo q ya tiene la etiqueta del Nutriscore y le pone mala nota (?). Cómo estamos tragando con estas chorradas americanas?	I am drinking a delicious fruit smoothie: pineapple juice, banana, mango, coconut milk, lemon juice and suddenly I notice that it already has the Nutriscore label and it gives it a bad grade (?). How are we swallowing with this American bullshit?
T7 NS adoption	label nutrition consumer traffic light quality new frontal information France	21.2%	Unión Europea: La etiqueta NutriScore es efectiva para elegir alimentos saludables	European Union: The NutriScore label is effective for making healthy food choices
			Es necesario mejorar la forma en la que se informa al consumidor sobre la calidad nutricional de lo que consume. El Nutriscore es un método validado e intuitivo. Por eso yo ya firmé para que sea obligatoria su implantación en Europa	It is necessary to improve the way in which consumers are informed about the nutritional quality of what they consume. The Nutriscore is a validated and intuitive method. That is why I already signed so that its implementation in Europe is mandatory
			La Sociedad Francesa de Nutrición (SFN) apoya la Iniciativa Ciudadana Europea PRO-NUTRISCORE lanzada por 7 asociaciones de consumidores para hacer obligatorio el #NutriScore en Europa	The French Society for Nutrition (SFN) supports the European Citizens' Initiative PRO-NUTRISCORE launched by 7 consumer associations to make the #NutriScore mandatory in Europe

T8 NS vs. traditional foods	Jamon Iberico to see do it seemed EVOO classification time has to reason	7.1%	El tratamiento del #AOVE como una grasa similar a la colza, es una absoluta insensatez. Revisen por favor estos modelos nutricionales de «corrección alimentaria» cancelación de nuestra cultura gastronómica	Treating the #EVOO as a rapeseed-like fat is absolute nonsense. Please review these nutritional models of "food correction" cancellation of our gastronomic culture
			El jamón ibérico aporta proteínas de alto valor biológico que proporcionan aminoácidos esenciales y lípidos con cierto grado de instauración que favorecen su digestibilidad #Nutriscore #100 × 100 nuestra #YoAceiteyJamon #cerdoiberico #jamon #saludable	Iberian ham provides proteins of high biological value that provide essential amino acids and lipids with a certain degree of establishment that favor its digestibility #Nutriscore #100 × 100 nuestra #YoAceiteyJamon #cerdoiberico #jamon #saludable
			Poco se le ha linchado al NutriScore para lo que se merece. Y cuando un jamón baje su nivel de sal, dejará de ser jamón. Pongamos (consumamos) el jamón como lo que es y dejemos de retorcer la realidad para acomodarla a nuestra conveniencia	NutriScore was less lynched than it deserves. And when a ham lowers its salt level, it will stop being a ham. Let's put (consume) the ham for what it is and stop distorting reality to adapt it to our liking
T9 NS calculation: technical aspects	sugar fat ultra-processed cereal salt extra calories amount high neither	9.2%	En cada producto se tienen en cuenta aspectos… Negativos: la cantidad de calorías, azúcares, grasas saturadas y sal, y Positivos: el porcentaje de frutas o verduras empleado para obtener el producto, y su aporte de fibra y proteínas	These Aspects are taken into account in each product...Negatives: the amount of calories, sugars, saturated fats and salt, and Positives: the percentage of fruits or vegetables used to obtain the product, and its contribution of fiber and protein
			Un vaso de Cacaolat Veggie contiene 35,6 g de azúcar, equivalente a 8,9 terrones. NutriScore B	A glass of Cacaolat Veggie contains 35.6 g of sugar, equivalent to 8.9 cubes. NutriScore B
			El nutriscore califica como C al aceite de oliva y eso que lo modificaron. Antes tenía una D. Pero montones de ultraprocesados califican como A	The nutriscore classifies olive oil as C-and they modified it-. It used to have a D. But lots of ultra-processed (products) are classified as A
T10 NS vs. olive oil (and other traditional products)	olive less industry to eat value oil benefit coke see want	8.3%	La defensa del Ministerio es anular al aceite de oliva. Eso es ayuda? El Ministerio de Consumo defenderá los beneficios nutricionales del aceite de oliva en el Nutri-Score	The Ministry's defense is to annul (the label on) olive oil. Is that help? The Ministry of Consumption will defend the nutritional benefits of olive oil in the Nutri-Score
			El sector oleícola traslada al ministro de Consumo el problema del NutriScore 'Considera que minusvalora los beneficios saludables del consumo de aceites de oliva'	The olive sector transfers the NutriScore problem to the Minister of Consumption "It considers that it undervalues the healthy benefits of consuming olive oils"
			✓ En su opinión, dicha clasificación no refleja los #beneficios #nutricionales del aceite de oliva y lo equipara con el de otras grasas como el aceite de colza.	✓ In his opinion, this classification does not reflect the #nutritional #benefits of olive oil and equates it with that of other fats such as rapeseed oil.

Appendix 3.B

Table A3.2. Topics identified in the scientific literature corpus

Topic	Most Typical Terms	Prevalence	Exemplary Documents (Title and Reference)	Article Addressing the Topic (Topic Prevalence > 25%)
T1 Impact OF FOP labels on healthy choices	FOP condition* perceive attention without experiment* segment label * online estimation	11.6%	Experimental study of front-of-package nutrition labels' efficacy on perceived healthfulness of sugar-sweetened beverages among youth in six countries [80] Nutri-Score, multiple traffic light and incomplete nutrition labelling on food packages: Effects on consumers' accuracy in identifying healthier snack options [87] The use of food swaps to encourage healthier online food choices: a randomized controlled trial [81]	[42–48,80,81,87–105]
T2** Advertisements drive unhealthy food choices	advertisment* children companies adolescents commitment television Spain obesity package* value*	9.5%	Food advertising and prevention of childhood obesity in Spain: Analysis of the nutritional value of the products and discursive strategies used in the ads most viewed by children from 2016 to 2018 [70] Soft drinks and sugar-sweetened beverages advertising in Spain: Correlation between nutritional values and advertising discursive strategies [65] Breakfast food advertising and prevention of obesity: Analysis of the nutritional value of the products and discursive strategies used in the breakfast ads from 2015 to 2019 [66]	[18,65–70,85,104,106–114]
T3 NS and ultra-processed foods	ultra-processed natur* bars *green* cereals UPF (ultra-processed Food) process	6.5%	Association between heat-induced chemical markers and ultra-processed foods: A case study on breakfast cereals [115] Naturalness and healthiness in ultra-processed foods: A multidisciplinary perspective and case study [71] Respective contribution of ultra-processing and nutritional quality of foods to the overall diet	[71,72,83,86,115–121]

	HMF (hydroxymethylfurfural) degree NOVA (classification)		quality: results from the NutriNet-Santé study [116]	
T4 Different nutrient profiling systems	sale* interpretation scheme warning HSR (Health Star Rating) OFCOM (Office of Communication) PAHO (Pan-American Health Organization) valid store classification	7.5%	Comparison of nutrient profiling models for assessing the nutritional quality of foods: A validation study [62] Food Compass is a nutrient profiling system using expanded characteristics for assessing healthfulness of foods [122] Facilitating consumers choice of healthier foods: A comparison of different front-of-package labelling schemes using Slovenian food supply database [123]	[18,62–64,86,98,101,110,122–127]
T5** Assessment of nutritional quality of food through the NS	meat price cart cheese shop arm* analogous RIs (Reference Intakes) lower point	8.0%	Plant-Based Alternative Products: Are They Healthy Alternatives? Micro- and Macronutrients and Nutritional Scoring [128] Dietary intake assessment of pre-packed graviera cheese in Greece and nutritional characterization using the Nutri-score front of pack label scheme [129] Assessment of price and nutritional quality of gluten-free products: Versus their analogues with gluten through the algorithm of the Nutri-score front-of-package labeling system [73]	[73–76,128–135]
T6 Assessment of NS performance and adherence with dietary guidelines	algorithm grain carbohydrates align guidelines nuts discriminatory component pyramid dietary	10.5%	Evaluation of the ability of Nutri-score to discriminate the nutritional quality of prepacked foods using a sale-weighting approach [57] Alignment of Nutri-Score with Mediterranean Diet Pyramid: A Food Level Analysis [54] Performance of the front-of-pack nutrition label Nutri-score to discriminate the nutritional quality of foods products: A comparative study across 8 European countries [59]	[54–61,126,131,136–143]
T7	nutriRECIPE environment	7.4%	A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally	[7,8,11,49,50,96,103,112,144–148]

Nutritional evaluation and environmental impact of food products	burger milk EII (Environmental Impact Index) plant-based beef Eco-Score meal alternative		friendly food choices? Evidence from a consumer experiment in Belgium [50] Meat substitution in burgers: nutritional scoring, sensorial testing, and Life Cycle Assessment [144] The nutriRECIPE-Index—development and validation of a nutrient-weighted index for the evaluation of recipes [145]	
T8 Medical aspects	mortal FSAm-NPS cohort association weight cancer risk dietary FSA-NP hazard	9.7%	Association between nutritional profiles of foods underlying Nutri-Score front-of-pack labels and mortality: EPIC cohort study in 10 European countries [149] Nutritional quality of food as represented by the FSAm-NPS nutrient profiling system underlying the Nutri-Score label and cancer risk in Europe: Results from the EPIC prospective cohort study [82] Food consumption based on the nutrient profile system underlying the Nutri-Score and renal function in older adults [52]	[51–53,82,84,116,149–158]
T9 NS understanding and policy debates	olive Italian rank oil Italy NS cake behaviour pizza correct	7.6%	Assessing the effectiveness of front of pack labels: Findings from an online randomised-controlled experiment in a representative British sample [159] Legitimacy of Front-of-Pack Nutrition Labels: Controversy Over the Deployment of the Nutri-Score in Italy [10] Is FOP nutrition label Nutri-score well understood by consumers when comparing the nutritional quality of added fats, and does it negatively impact the image of olive oil? [12]	[10,12,34,40,41,79,83,143,159–165]

T10 Understanding of different FOP labels	FOPL understand perception multiple reference traffic light trust format star	17.7%	Improving the understanding of key nutritional elements to support healthier and more informed food choices: The effect of front-of-pack label bundles [166] Consumers' responses to front-of-pack nutrition labelling: Results from a sample from the Netherlands [36] Objective understanding of the Nutri-score front-of-pack label by European consumers and its effect on food choices: an online experimental study [167]	[6,18,33–38,78,97,102,105,111,117,142,154,155,160,161,163,164,166–176]

References

1) World Health Organization. Malnutrition: Fact Sheets; WHO: Geneva, Switzerland, 2021.
2) Wartella, E.A.; Lichtenstein, A.H.; Boon, C.S. (Eds.) Examination of Front-of-Package Nutrition Rating Systems and Symbols: Phase I Report; National Academies Press: Washington, UT, USA, 2010; ISBN 9780309158275.
3) World Health Organization. Global Strategy on Diet, Physical Activity and Health; WHO: Geneva, Switzerland, 2004.
4) Kanter, R.; Vanderlee, L.; Vandevijvere, S. Front-of-package nutrition labelling policy: Global progress and future directions. Public Health Nutr. 2018, 21, 1399–1408.
5) Temple, N.J. Front-of-package food labels: A narrative review. Appetite 2020, 144, 104485. https://doi.org/10.1016/j.appet.2019.104485.
6) Pettigrew, S.; Jongenelis, M.I.; Jones, A.; Hercberg, S.; Julia, C. An 18-country analysis of the effectiveness of five front-of-pack nutrition labels. Food Qual. Prefer. 2023, 104, 104691. https://doi.org/10.1016/J.FOODQUAL.2022.104691.
7) Schlarbaum, L.; Forner, F.; Bohn, K.; Amberg, M.; Mäder, P.; Lorkowski, S.; Meier, T. Nutritional Assessment of Ready-to-Eat Salads in German Supermarkets: Comparison of the nutriRECIPE-Index and the Nutri-Score. Foods 2022, 11, 4011. https://doi.org/10.3390/FOODS11244011.
8) Drewnowski, A. Most Plant-Based Milk Alternatives in the USDA Branded Food Products Database Do Not Meet Proposed Nutrient Standards or Score Well on Nutrient Density Metrics. Nutrients 2022, 14, 4767. https://doi.org/10.3390/NU14224767.
9) Julia, C.; Hercberg, S. Research and lobbying conflicting on the issue of a front-of-pack nutrition labelling in France. Arch. Pub-lic Health 2016, 74, 51. https://doi.org/10.1186/s13690-016-0162-8.
10) Fialon, M.; Nabec, L.; Julia, C. Legitimacy of Front-of-Pack Nutrition Labels: Controversy Over the Deployment of the Nu-tri-Score in Italy. Int. J. Health Policy Manag. 2022, 11, 2574–2587. https://doi.org/10.34172/ijhpm.2022.6127.
11) Stiletto, A.; Trestini, S. Is it really a piece of cake to label Geographical Indications with the Nutri-Score ? Consumers' behav-iour and policy implications. PLoS ONE 2022, 17, e0277048. https://doi.org/10.1371/journal.pone.0277048.
12) Fialon, M.; Salas-Salvadó, J.; Babio, N.; Touvier, M.; Hercberg, S.; Galan, P. Is fop nutrition label nutri-score well understood by consumers when comparing the nutritional quality of added fats, and does it negatively impact the image of olive oil? Foods 2021, 10, 2209. https://doi.org/10.3390/foods10092209.
13) Bilal, M.; Oxentenko, A.S. The Impact of Twitter: Why Should You Get Involved, and Tips and Tricks to Get Started. Am. J. Gas-troenterol. 2020, 115, 1549–1552.

https://doi.org/10.14309/ajg.0000000000000763.

14) Parwani, P.; Choi, A.D.; Lopez-Mattei, J.; Raza, S.; Chen, T.; Narang, A.; Michos, E.D.; Erwin, J.P.; Mamas, M.A.; Gulati, M. Un-derstanding Social Media: Opportunities for Cardiovascular Medicine. J. Am. Coll. Cardiol. 2019, 73, 1089–1093. https://doi.org/10.1016/j.jacc.2018.12.044.
15) Xue, J.; Chen, J.; Chen, C.; Zheng, C.; Li, S.; Zhu, T. Public discourse and sentiment during the COVID 19 pandemic: Using Latent Dirichlet Allocation for topic modeling on Twitter. PLoS ONE 2020, 15, e0239441. https://doi.org/10.1371/journal.pone.0239441.
16) Ola, O.; Sedig, K. Understanding Discussions of Health Issues on Twitter: A Visual Analytic Study. Online J. Public Health In-form. 2020, 12, e2. https://doi.org/10.5210/ojphi.v12i1.10321.
17) Pershad, Y.; Hangge, P.T.; Albadawi, H.; Oklu, R. Social medicine: Twitter in healthcare. J. Clin. Med. 2018, 7, 121. https://doi.org/10.3390/jcm7060121.
18) Septia Irawan, A.; Shahin, B.; Wangeshi Njuguna, D.; Nellamkuzhi, N.J.; Thiện, B.Q.; Mahrouseh, N.; Varga, O. Analysis of Content, Social Networks, and Sentiment of Front-of-Pack Nutrition Labeling in the European Union on Twitter. Front. Nutr. 2022, 9, 846730. https://doi.org/10.3389/fnut.2022.846730.
19) Lyu, J.C.; Le Hann, E.; Luli, G.K. COVID-19 Vaccine–Related Discussion on Twitter: Topic Modeling and Sentiment Analysis. J. Med. Internet Res. 2021, 23, e24435. https://doi.org/10.2196/24435.
20) Liberati, A.; Altman, D.G.; Tetzlaff, J.; Mulrow, C.; Gøtzsche, P.C.; Ioannidis, J.P.A.; Clarke, M.; Devereaux, P.J.; Kleijnen, J.; Moher, D. Guidelines and Guidance the PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration. PLOS Med. 2009, 6, e1000100. https://doi.org/10.1371/journal.pmed.1000100.
21) Grunert, K.G.; Wills, J.M. A review of European research on consumer response to nutrition information on food labels. J. Pub-lic Health 2007, 15, 385–399. https://doi.org/10.1007/s10389-007-0101-9.
22) Stiletto, A.; Trestini, S. Factors behind consumers' choices for healthy fruits: A review of pomegranate and its food deriva-tives. Agric. Food Econ. 2021, 9, 31. https://doi.org/10.1186/s40100-021-00202-7.
23) Michel-Villarreal, R.; Hingley, M.; Canavari, M.; Bregoli, I. Sustainability in alternative food networks: A systematic litera-ture review. Sustainability 2019, 11, 859. https://doi.org/10. 3390/ su110 30859.
24) Cantillo, J.; Martín, J.C.; Román, C. Discrete choice experiments in the analysis of consumers' preferences for finfish products: A systematic literature review. Food Qual. Prefer. 2020, 84, 103952. https://doi.org/10.1016/j.foodqual.2020.103952.
25) Arribas, L.; Hurtós, L.; Sendrós, M.J.; Peiró, I.; Salleras, N.; Fort, E.; Sánchez-Migallón, J.M. NUTRISCORE: A new nutritional screening tool for oncological outpatients. Nutrition 2017, 33,

297–303. https://doi.org/10.1016/j.nut.2016.07.015.

26) Roberts, M.E.; Stewart, B.M.; Tingley, D. stm: R Package for Structural Topic Models. J. Stat. Softw. 2019, 91, 1–40. https://doi.org/10.18637/jss.v000.i00.

27) Cei, L.; Defrancesco, E.; Stefani, G. What topic modelling can show about the development of agricultural economics: Evidence from the Journal Citation Report category top journals. Eur. Rev. Agric. Econ. 2022, 49, 289–330. https://doi.org/10.1093/erae/jbab055.

28) Villa-Cox, G.; Bucaram-Villacís, S.J.; Goethals, P.; Speelman, S. Mapping linkages between ecosystem services and agricultural and landscape management using structural topic modeling of scientific literature. Ecosyst. Serv. 2023, 61, 101525. https://doi.org/10.1016/j.ecoser.2023.101525.

29) Windel, F.; Than, N.; Perkins, K.M.; Rodriguez, M.Y. Color-blind and racially suppressive discourses on German-speaking Twitter: A mixed method analysis of the Hanau White nationalist shootings. J. Community Appl. Soc. Psychol. 2023, 33, 587–607. https://doi.org/10.1002/casp.2672.

30) Roberts, M.E.; Stewart, B.M.; Tingley, D.; Lucas, C.; Leder-Luis, J.; Gadarian, S.K.; Albertson, B.; Rand, D.G. Structural Topic Models for Open-Ended Survey Responses. Am. J. Pol. Sci. 2014, 58, 1064–1082. https://doi.org/10.1111/AJPS.12103.

31) Roberts, M.E.; Stewart, B.M.; Tingley, D.; Airoldi, E.M. The Structural Topic Model and Applied Social Science. In Proceedings of the Advances in Neural Information Processing Systems, Lake Tahoe, NV, USA, 5–10 December 2013.

32) Lindstedt, N.C. Structural Topic Modeling for Social Scientists: A Brief Case Study with Social Movement Studies Literature, 2005–2017. Soc. Curr. 2019, 6, 307–318. https://doi.org/10.1177/2329496519846505.

33) Aguenaou, H.; El Ammari, L.; Bigdeli, M.; El Hajjab, A.; Lahmam, H.; Labzizi, S.; Gamih, H.; Talouizte, A.; Serbouti, C.; El Kari, K.; et al. Comparison of appropriateness of Nutri-Score and other front-of-pack nutrition labels across a group of Moroccan consumers: Awareness, understanding and food choices. Arch. Public Health 2021, 79, 71. https://doi.org/10.1186/s13690-021-00595-3.

34) Egnell, M.; Ducrot, P.; Touvier, M.; Allès, B.; Hercberg, S.; Kesse-Guyot, E.; Julia, C. Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: Comparisons with other format labels. PLoS ONE 2018, 13, e0202095. https://doi.org/10.1371/journal.pone.0202095.

35) Vandevijvere, S.; Vermote, M.; Egnell, M.; Galan, P.; Talati, Z.; Pettigrew, S.; Hercberg, S.; Julia, C. Consumers' food choices, understanding and perceptions in response to different front-of-pack nutrition labelling systems in Belgium: Results from an online experimental study. Arch. Public Health 2020, 78, 30. https://doi.org/10.1186/s13690-020-00404-3.

36) Egnell, M.; Talati, Z.; Gombaud, M.; Galan, P.; Hercberg, S.; Pettigrew, S.; Julia, C. Consumers' responses to front-of-pack nu-trition labelling: Results from a sample from the Netherlands. Nutrients 2019, 11, 1817. https://doi.org/10.3390/nu11081817.
37) Cui, J.; Yan, R.; Astell-Burt, T.; Gong, E.; Zheng, L.; Li, X.; Zhang, J.; Xiang, L.; Ye, L.; Hu, Y.; et al. Types and Aspects of Front-of-Package Labeling Preferred by Parents: Insights for Policy Making in China. Nutrients 2022, 14, 800. https://doi.org/10.3390/nu14040800.
38) Santos, O.; Alarcão, V.; Feteira-Santos, R.; Fernandes, J.; Virgolino, A.; Sena, C.; Vieira, C.P.; Gregório, M.J.; Nogueira, P.; Graça, P.; et al. Impact of different front-of-pack nutrition labels on online food choices. Appetite 2020, 154, 104795. https://doi.org/10.1016/j.appet.2020.104795.
39) Mazzù, M.F.; Romani, S.; Gambicorti, A. Effects on consumers' subjective understanding of a new front-of-pack nutritional label: A study on Italian consumers. Int. J. Food Sci. Nutr. 2020, 72, 357–366. https://doi.org/10.1080/09637486.2020.1796932.
40) Riccò, M.; Ranzieri, S.; Balzarini, F.; Vezzosi, L.; Marchesi, F.; Valente, M.; Peruzzi, S. Understanding of the Nutri-Score front-of-pack label by Italian Medical Professionals and its effect on food choices: A web-based study on knowledge, attitudes and practices. Acta Biomed. 2022, 93, e2022042. https://doi.org/10.23750/abm.v93i2.11191.
41) Sarda, B.; Julia, C.; Serry, A.J.; Ducrot, P. Appropriation of the front-of-pack nutrition label nutri-score across the french popu-lation: Evolution of awareness, support, and purchasing behaviors between 2018 and 2019. Nutrients 2020, 12, 2887. https://doi.org/10.3390/nu12092887.
42) Fuchs, K.L.; Lian, J.; Michels, L.; Mayer, S.; Toniato, E.; Tiefenbeck, V. Effects of Digital Food Labels on Healthy Food Choices in Online Grocery Shopping. Nutrients 2022, 14, 2044.
43) Shin, S.; van Dam, R.M.; Finkelstein, E.A. The effect of dynamic food labels with real-time feedback on diet quality: Results from a randomized controlled trial. Nutrients 2020, 12, 2158. https://doi.org/10.3390/nu12072158.
44) Finkelstein, E.A.; Ang, F.J.L.; Doble, B.; Wong, W.H.M.; Van Dam, R.M. A randomized controlled trial evaluating the relative effectiveness of the multiple trafic light and nutri-score front of package nutrition labels. Nutrients 2019, 11, 2236. https://doi.org/10.3390/nu11092236.
45) Kühne, S.J.; Reijnen, E.; Granja, G.; Hansen, R.S. Labels Affect Food Choices, but in What Ways? Nutrients 2022, 14, 3204. https://doi.org/10.3390/nu14153204.
46) De Temmerman, J.; Heeremans, E.; Slabbinck, H.; Vermeir, I. The impact of the Nutri-Score nutrition label on perceived health-iness and purchase intentions. Appetite 2021, 157, 104995. https://doi.org/10.1016/J.APPET.2020.104995.
47) Dubois, P.; Albuquerque, P.; Allais, O.; Bonnet, C.; Bertail, P.; Combris, P.; Lahlou, S.; Rigal, N.; Ruffieux, B.; Chandon, P. Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: Evidence from a large-scale randomized controlled trial. J. Acad. Mark. Sci. 2021,

49, 119–138. https://doi.org/10.1007/s11747-020-00723-5.

48) Mora-García, C.A.; Tobar, L.F.; Young, J.C. The effect of randomly providing nutri-score information on actual purchases in Colombia. Nutrients 2019, 11, 491. https://doi.org/10.3390/nu11030491.

49) De Bauw, M.; De, L.S.; Revilla, L.; Poppe, V.; Matthys, C.; Vranken, L. Digital nudges to stimulate healthy and pro-environmental food choices in E-groceries. Appetite 2022, 172, 105971. https://doi.org/10.1016/j.appet.2022.105971.

50) De Bauw, M.; Matthys, C.; Poppe, V.; Franssens, S.; Vranken, L. A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. Food Qual. Prefer. 2021, 93, 104276. https://doi.org/10.1016/j.foodqual.2021.104276.

51) Donat-Vargas, C.; Sandoval-Insausti, H.; Rey-García, J.; Ramón Banegas, J.; Rodríguez-Artalejo, F.; Guallar-Castillón, P. Five-color Nutri-Score labeling and mortality risk in a nationwide, population-based cohort in Spain: The Study on Nutrition and Cardiovascular Risk in Spain (ENRICA). Am. J. Clin. Nutr. 2021, 113, 1301–1311. https://doi.org/10.1093/ajcn/nqaa389.

52) Montero-Salazar, H.; Guallar-Castill, P.; Banegas, J.R.; Åkesson, A.; Rey-García, J.; Rodríguez-Artalejo, F.; Donat-Vargas, C. Food consumption based on the nutrient profile system underlying the Nutri-Score and renal function in older adults. Clin. Nutr. 2022, 41, 1541–1548. https://doi.org/10.1016/j.clnu.2022.05.004.

53) Hu, E.A.; Pasupuleti, M.; Nguyen, V.; Langheier, J.; Shurney, D. Sustaining weight loss among adults with obesity using a digi-tal meal planning and food purchasing platform for 12, 24, and 36 months: A longitudinal study. Nutr. J. 2021, 20, 8. https://doi.org/10.1186/S12937-021-00666-9/TABLES/2.

54) Vlassopoulos, A.; Katidi, A.; Savvidou, T.; Kapsokefalou, M. Alignment of Nutri-Score with Mediterranean Diet Pyramid: A Food Level Analysis. Nutrients 2022, 14, 5097. https://doi.org/10.3390/nu14235097.

55) ter Borg, S.; Steenbergen, E.; Milder, I.E.J.; Temme, E.H.M. Evaluation of Nutri-Score in Relation to Dietary Guidelines and Food Reformulation in The Netherlands. Nutrients 2021, 13, 4536. https://doi.org/10.3390/nu13124536.

56) Szabo De Edelenyi, F.; Egnell, M.; Galan, P.; Druesne-Pecollo, N.; Hercberg, S.; Julia, C. Ability of the Nutri-Score front-of-pack nutrition label to discriminate the nutritional quality of foods in the German food market and consistency with nutritional recommendations. Arch. Public Health 2019, 77, 28. https://doi.org/10.1186/s13690-019-0357-x.

57) Hafner, E.; Pravst, I. Evaluation of the ability of nutri-score to discriminate the nutritional quality of prepacked foods using a sale-weighting approach. Foods 2021, 10, 1689. https://doi.org/10.3390/foods10081689.

58) Vlassopoulos, A.; Katidi, A.; Kapsokefalou, M. Performance and discriminatory capacity of Nutri-Score in branded foods in Greece. Front. Nutr. 2022, 9, 993238. https://doi.org/10.3389/fnut.2022.993238.

59) Dréano-Trécant, L.; Egnell, M.; Hercberg, S.; Galan, P.; Soudon, J.; Fialon, M.; Touvier, M.; Kesse-Guyot, E.; Julia, C. Perfor-mance of the front-of-pack nutrition label nutri-score to discriminate the nutritional quality of foods products: A comparative study across 8 european countries. Nutrients 2020, 12, 1303. https://doi.org/10.3390/nu12051303.

60) Braesco, V.; Ros, E.; Govindji, A.; Bianchi, C.; Becqueriaux, L.; Quick, B. A Slight Adjustment of the Nutri-Score Nutrient Profil-ing System Could Help to Better Reflect the European Dietary Guidelines Regarding Nuts. Nutrients 2022, 14, 2668. https://doi.org/10.3390/NU14132668.

61) Kissock, K.R.; Vieux, F.; Mathias, K.C.; Drewnowski, A.; Seal, C.J.; Masset, G.; Smith, J.; Mejborn, H.; Mckeown, N.M.; Beck, E.J.; et al. Aligning nutrient profiling with dietary guidelines: Modifying the Nutri-Score algorithm to include whole grains. Eur. J. Nutr. 2022, 61, 541–553. https://doi.org/10.1007/s00394-021-02718-6.

62) Poon, T.; Labonté, M.È.; Mulligan, C.; Ahmed, M.; Dickinson, K.M.; L'Abbé, M.R. Comparison of nutrient profiling models for assessing the nutritional quality of foods: A validation study. Br. J. Nutr. 2018, 120, 567–582. https://doi.org/10.1017/S0007114518001575.

63) Valenzuela, A.; Zambrano, L.; Velásquez, R.; Groff, C.; Apablaza, T.; Riffo, C.; Moldenhauer, S.; Brisso, P.; Leonario-Rodriguez, M. Discrepancy between Food Classification Systems: Evaluation of Nutri-Score, NOVA Classification and Chilean Front-of-Package Food Warning Labels. Int. J. Environ. Res. Public Health 2022, 19, 14631. https://doi.org/10.3390/IJERPH192214631.

64) Dickie, S.; Woods, J.; Machado, P.; Lawrence, M. Nutrition Classification Schemes for Informing Nutrition Policy in Australia: Nutrient-Based, Food-Based, or Dietary-Based? Curr. Dev. Nutr. 2022, 6, nzac112. https://doi.org/10.1093/cdn/nzac112.

65) Blasco, M.M.; Jiménez-Morales, M. Soft drinks and sugar-sweetened beverages advertising in Spain: Correlation between nu-tritional values and advertising discursive strategies. Int. J. Environ. Res. Public Health 2020, 17, 2335. https://doi.org/10.3390/ijerph17072335.

66) Blasco, M.M.; Jiménez-Morales, M. Breakfast food advertising and prevention of obesity: Analysis of the nutritional value of the products and discursive strategies used in the breakfast ads from 2015 to 2019. Nutrients 2021, 13, 231. https://doi.org/10.3390/nu13010231.

67) Jiménez-Morales, M.; Montaña Blasco, M. Presence and strategic use of the Mediterranean Diet in food marketing: Analysis and association of nutritional values and advertising claims from 2011 to 2020. NFS J. 2021, 24, 1–6. https://doi.org/10.1016/j.nfs.2021.04.003.

68) Meyerding, S.G.H.; Marpert, J.D. Modern pied pipers: Child social media influencers and junk food on YouTube: A study from Germany. Appetite 2023, 181, 106382. https://doi.org/10.1016/j.appet.2022.106382.

69) Escalon, H.; Courbet, D.; Julia, C.; Srour, B.; Hercberg, S.; Serry, A.J. Exposure of French Children and Adolescents to Advertis-ing for Foods High in Fat, Sugar or Salt. Nutrients 2021, 13, 3741. https://doi.org/10.3390/NU13113741.
70) Montaña, M.; Jiménez-Morales, M.; Vàzquez, M. Food Advertising and Prevention of Childhood Obesity in Spain: Analysis of the Nutritional Value of the Products and Discursive Strategies Used in the Ads Most Viewed by Children from 2016 to 2018. Nutrients 2019, 11, 2873. https://doi.org/10.3390/NU11122873.
71) Sanchez-Siles, L.; Roman, S.; Fogliano, V.; Siegrist, M. Naturalness and healthiness in "ultra-processed foods": A multidisci-plinary perspective and case study. Trends Food Sci. Technol. 2022, 129, 667–673. https://doi.org/10.1016/j.tifs.2022.11.009.
72) Ebner, P.; Frank, K.; Christodoulou, A.; Davidou, S. How are the processing and nutrient dimensions of foods interconnected? an issue of hierarchy based on three different food scores. Int. J. Food Sci. Nutr. 2022, 73, 770–785. https://doi.org/10.1080/09637486.2022.2060951.
73) De Las Heras-Delgado, S.; De Las Nieves Alías-Guerrero, A.; Cendra-Duarte, E.; Salas-Salvadó, J.; Vilchez, E.; Roger, E.; Her-nández-Alonso, P.; Babio, N. Assessment of price and nutritional quality of gluten-free products versus their analogues with gluten through the algorithm of the nutri-score front-of-package labeling system. Food Funct. 2021, 12, 4424–4433. https://doi.org/10.1039/D0FO02630A.
74) Cutroneo, S.; Angelino, D.; Tedeschi, T.; Pellegrini, N.; Martini, D. Nutritional Quality of Meat Analogues: Results from the Food Labelling of Italian Products (FLIP) Project. Front. Nutr. 2022, 9, 852831. https://doi.org/10.3389/FNUT.2022.852831/BIBTEX.
75) Egnell, M.; Boutron, I.; Péneau, S.; Ducrot, P.; Touvier, M.; Galan, P.; Buscail, C.; Porcher, R.; Ravaud, P.; Hercberg, S.; et al. Ran-domised controlled trial in an experimental online supermarket testing the effects of front-of-pack nutrition labelling on food purchasing intentions in a low-income population. BMJ Open 2021, 11, e041196. https://doi.org/10.1136/BMJOPEN-2020-041196.
76) Poinsot, R.; Vieux, F.; Dubois, C.; Perignon, M.; Méjean, C.; Darmon, N. Nutritional quality of vegetarian and non-vegetarian dishes at school: Are nutrient profiling systems sufficiently informative? Nutrients 2020, 12, 2256. https://doi.org/10.3390/nu12082256.
77) Cei, L.; Stefani, G.; Defrancesco, E. How do local factors shape the regional adoption of geographical indications in Europe? Evidences from France, Italy and Spain | Elsevier Enhanced Reader. Food Policy 2021, 105, 102170.
78) Baccelloni, A.; Giambarresi, A.; Mazzù, M.F. Effects on consumers' subjective understanding and liking of front-of-pack nutri-tion labels: A study on slovenian and dutch consumers. Foods 2021,

10, 2958. https://doi.org/10.3390/foods10122958.

79) Fialon, M.; Serafini, M.; Galan, P.; Kesse-Guyot, E.; Touvier, M.; Deschasaux-Tanguy, M.; Sarda, B.; Hercberg, S.; Nabec, L.; Julia, C. Nutri-Score and NutrInform Battery: Effects on Performance and Preference in Italian Consumers. Nutrients 2022, 14, 3511. https://doi.org/10.3390/nu14173511.

80) Hock, K.; Acton, R.B.; Jáuregui, A.; Vanderlee, L.; White, C.M.; Hammond, D. Experimental study of front-of-package nutrition labels' efficacy on perceived healthfulness of sugar-sweetened beverages among youth in six countries. Prev. Med. Rep. 2021, 24, 101577.

81) Jansen, L.; van Kleef, E.; Van Loo, E.J. The use of food swaps to encourage healthier online food choices: A randomized con-trolled trial. Int. J. Behav. Nutr. Phys. Act. 2021, 18, 156. https://doi.org/10.1186/s12966-021-01222-8.

82) Deschasaux, M.; Huybrechts, I.; Murphy, N.; Julia, C.; Hercberg, S.; Srour, B.; Kesse-Guyot, E.; Latino-Martel, P.; Biessy, C.; Casagrande, C.; et al. Nutritional quality of food as represented by the FSAm-NPS nutrient profiling system underlying the Nutri-Score label and cancer risk in Europe: Results from the EPIC prospective cohort study. PLOS Med. 2018, 15, e1002651.

83) Bolhuis, D.; Mosca, A.C.; Pellegrini, N. Consumer Awareness of the Degree of Industrial Food Processing and the Association with Healthiness—A Pilot Study. Nutrients 2022, 14, 4438. https://doi.org/10.3390/nu14204438.

84) Bonaccio, M.; Di Castelnuovo, A.; Ruggiero, E.; Costanzo, S.; Grosso, G.; De Curtis, A.; Cerletti, C.; Donati, M.B.; De Gaetano, G.; Iacoviello, L. Joint association of food nutritional profile by Nutri-Score front-of-pack label and ultra-processed food intake with mortality: Moli-sani prospective cohort study. BMJ 2022, 378, e070688. https://doi.org/10.1136/bmj-2022-070688.

85) Richonnet, C.; Mosser, F.; Favre, E.; Robert, M.; Martin, F.; Thiebaut, I. Nutritional quality and degree of processing of chil-dren's foods assessment on the french market. Nutrients 2022, 14, 171. https://doi.org/10.3390/nu14010171.

86) Romero Ferreiro, C.; Lora Pablos, D.; Gómez de la Cámara, A. Two dimensions of nutritional value: Nutri-score and nova. Nutrients 2021, 13, 2783. https://doi.org/10.3390/nu13082783.

87) Hagmann, D.; Siegrist, M. Nutri-Score, multiple traffic light and incomplete nutrition labelling on food packages: Effects on consumers' accuracy in identifying healthier snack options. Food Qual. Prefer. 2020, 83, 103894. https://doi.org/10.1016/J.FOODQUAL.2020.103894.

88) Potter, C.; Pechey, R.; Cook, B.; Bateman, P.; Stewart, C.; Frie, K.; Clark, M.; Piernas, C.; Rayner, M.; Jebb, S.A. Effects of environ-mental impact and nutrition labelling on food purchasing: An experimental online supermarket study. Appetite 2023, 180, 106312. https://doi.org/10.1016/j.appet.2022.106312.

89) Gabor, A.M.; Stojnić, B.; Ban Ostić, D. Effects of different nutrition labels on visual attention and accuracy of nutritional qual-ity perception—Results of an experimental eye-tracking study.

Food Qual. Prefer. 2020, 84, 103948. https://doi.org/10.1016/j.foodqual.2020.103948.

90) Isabel Sonntag, W.; Lemken, D.; Spiller, A.; Schulze, M. Welcome to the (label) jungle? Analyzing how consumers deal with in-tra-sustainability label trade-offs on food. Food Qual. Prefer. 2023, 104, 104746. https://doi.org/10.1016/j.foodqual.2022.104746.
91) van den Akker, K.; Bartelet, D.; Brouwer, L.; Luijpers, S.; Nap, T.; Havermans, R. The impact of the nutri-score on food choice: A choice experiment in a Dutch supermarket. Appetite 2022, 168, 105664. https://doi.org/10.1016/j.appet.2021.105664.
92) Godden, E.; Thornton, L.; Avramova, Y.; Dens, N. High hopes for front-of-pack (FOP) nutrition labels? A conjoint analysis on the trade-offs between a FOP label, nutrition claims, brand and price for different consumer segments. Appetite 2023, 180, 106356. https://doi.org/10.1016/J.APPET.2022.106356.
93) Poquet, D.; Ginon, E.; Goubel, B.; Chabanet, C.; Marette, S.; Issanchou, S.; Monnery-Patris, S. Impact of a front-of-pack nutri-tional traffic-light label on the nutritional quality and the hedonic value of mid-afternoon snacks chosen by mother-child dy-ads. Appetite 2019, 143, 104425. https://doi.org/10.1016/j.appet.2019.104425.
94) Gassler, B.; Faesel, C.K.; Moeser, A. Toward a differentiated understanding of the effect of Nutri-Score nutrition labeling on healthier food choices. Agribusiness 2023, 39, 28–50. https://doi.org/10.1002/agr.21762.
95) Castronuovo, L.; Tiscornia, M.V.; Guarnieri, L.; Martins, E.; Gomes, F.S.; Allemandi, L. Efficacy of different front-of-package labeling systems in changing purchase intention and product healthfulness perception for food products in Argentina. Rev. Panam. Salud Publica/Pan Am. J. Public Health 2022, 46, e137. https://doi.org/10.26633/RPSP.2022.137.
96) Hallez, L.; Qutteina, Y.; Boen, F.; Smits, T. The abc's of ecological and nutrition labels. The impact of label theme and complex-ity on the environmental footprint of online grocery choices. Sustainability 2021, 13, 2474. https://doi.org/10.3390/su13052474.
97) Bossuyt, S.; Custers, K.; Tummers, J.; Verbeyst, L.; Oben, B. Nutri-score and nutrition facts panel through the eyes of the con-sumer: Correct healthfulness estimations depend on transparent labels, fixation duration, and product equivocality. Nutrients 2021, 13, 2915. https://doi.org/10.3390/nu13092915.
98) Ares, G.; Varela, F.; Machin, L.; Antúnez, L.; Giménez, A.; Curutchet, M.R.; Aschemann-Witzel, J. Comparative performance of three interpretative front-of-pack nutrition labelling schemes: Insights for policy making. Food Qual. Prefer. 2018, 68, 215–225. https://doi.org/10.1016/J.FOODQUAL.2018.03.007.
99) Julia, C.; Arnault, N.; Agaësse, C.; Fialon, M.; Deschasaux-tanguy, M.; Andreeva, V.A.; Fezeu, L.K.; Kesse-guyot, E.; Touvier, M.; Galan, P.; et al. Impact of the front-of-pack label nutri-score on the nutritional quality of food choices in a quasi-experimental trial in catering. Nutrients 2021, 13,

4530. https://doi.org/10.3390/nu13124530.

100) Crosetto, P.; Lacroix, A.; Muller, L.; Ruffieux, B. Nutritional and economic impact of five alternative front-of-pack nutritional labels: Experimental evidence. Eur. Rev. Agric. Econ. 2020, 47, 785–818. https://doi.org/10.1093/erae/jbz037.

101) Medina-Molina, C.; Pérez-González, B. Nutritional labelling and purchase intention interaction of interpretative food labels with consumers' beliefs and decisions. Br. Food J. 2021, 123, 754–770. https://doi.org/10.1108/BFJ-04-2020-0353.

102) Talati, Z.; Egnell, M.; Hercberg, S.; Julia, C.; Pettigrew, S. Consumers' perceptions of five front-of-package nutrition labels: An experimental study across 12 countries. Nutrients 2019, 11, 1934. https://doi.org/10.3390/nu11081934.

103) Mora-Plazas, M.; Higgins, I.C.A.; Gomez, L.F.; Hall, M.; Parra, M.F.; Bercholz, M.; Murukutla, N.; Taillie, L.S. Impact of nutri-ent warning labels on choice of ultra-processed food and drinks high in sugar, sodium, and saturated fat in Colombia: A ran-domized controlled trial. PLoS ONE 2022, 17, e0263324. https://doi.org/10.1371/journal.pone.0263324.

104) Jurkenbeck, K.; Mehlhose, C.; Zuhlsdorf, A. The influence of the Nutri-Score on the perceived healthiness of foods labelled with a nutrition claim of sugar. PLoS ONE 2022, 17, e0272220. https://doi.org/10.1371/journal.pone.0272220.

105) Talati, Z.; Egnell, M.; Hercberg, S.; Julia, C.; Pettigrew, S. Food choice under five front-of-package nutrition label conditions: An experimental study across 12 countries. Am. J. Public Health 2019, 109, 1770–1775. https://doi.org/10.2105/AJPH.2019.305319.

106) Fernandez-Alvarez, M.D.M.; Zabaleta-del-Olmo, E.; Cachero-Rodríguez, J.; Martin-Payo, R. Nutritional content and quality of processed foods and beverages advertised near schools in three cities in the north of Spain. Nutr. Bull. 2023, 48, 66–73. https://doi.org/10.1111/nbu.12597.

107) Andrés, A.M.; Arroyo-Izaga, M.; Calvo, C.; Cervera, P.; Clotet, R.; Colomer, Y.; Escolástico, C.; Estruch, R.; Fregapane, G.; Frias, J.; et al. The front labelling of food: Nutritional traffic lights, nutri-score and others. Eur. Food Feed Law Rev. 2021, 16, 104–111.

108) Vandevijvere, S. Uptake of Nutri-Score during the first year of implementation in Belgium. Arch. Public Health 2020, 78, 10–12. https://doi.org/10.1186/s13690-020-00492-1.

109) Fondevila-Gascón, J.-F.; Berbel-Giménez, G.; Vidal-Portés, E.; Hurtado-Galarza, K. Ultra-Processed Foods in University Stu-dents: Implementing Nutri-Score to Make Healthy Choices. Healthcare 2022, 10, 984. https://doi.org/10.3390/healthcare10060984.

110) Rodríguez, F.A.M. Application of nutriscore and warning labels in foods targeting children in Spain. Pediatr. Aten. Primaria 2020, 22, 15–20.

111) Ducrot, P.; Julia, C.; Serry, A.-J. Nutri-Score: Awareness, Perception and Self-Reported Impact on Food Choices among French Adolescents. Nutrients 2022, 14, 3119.

https://doi.org/10.3390/nu14153119.

112) Fernández-Gaxiola, A.C.; Cruz-Casarrubias, C.; Pacheco-Miranda, S.; Marrón-Ponce, J.A.; Quezada, A.D.; García-Guerra, A.; Donovan, J. Access to Healthy Wheat and Maize Processed Foods in Mexico City: Comparisons across Socioeconomic Areas and Store Types. Nutrients 2022, 14, 1173. https://doi.org/10.3390/nu14061173.

113) Lorenzoni, G.; Di Benedetto, R.; Silano, M.; Gregori, D. What is the nutritional composition of ultra-processed food marketed in Italy? Nutrients 2021, 13, 2364. https://doi.org/10.3390/nu13072364.

114) Van Dam, I.; Reimes, N.; Vandevijvere, S. Benchmarking the nutrition-related commitments and practices of major Belgian food companies. Int. J. Behav. Nutr. Phys. Act. 2022, 19, 43. https://doi.org/10.1186/s12966-022-01269-1.

115) Morales, F.J.; Mesías, M.; Delgado-Andrade, C. Association between heat-induced chemical markers and ultra-processed foods: A case study on breakfast cereals. Nutrients 2020, 12, 1418. https://doi.org/10.3390/nu12051418.

116) Julia, C.; Baudry, J.; Fialon, M.; Hercberg, S.; Galan, P.; Srour, B.; Andreeva, V.A.; Touvier, M.; Kesse-Guyot, E. Respective con-tribution of ultra-processing and nutritional quality of foods to the overall diet quality: Results from the NutriNet-Santé study. Eur. J. Nutr. 2023, 62, 157–164. https://doi.org/10.1007/s00394-022-02970-4.

117) Savov, R.; Tkáč, F.; Chebeň, J.; Kozáková, J.; Berčík, J. Impact of different FOPL systems (Nutri-Score vs NutrInform) on con-sumer behaviour: Case study of the Slovak Republic. Amfiteatru Econ. 2022, 24, 797–816. https://doi.org/10.24818/EA/2022/61/797.

118) Vermote, M.; Bonnewyn, S.; Matthys, C.; Vandevijvere, S. Nutritional content, labelling and marketing of breakfast cereals on the belgian market and their reformulation in anticipation of the implementation of the nutri-score front-of-pack labelling system. Nutrients 2020, 12, 884. https://doi.org/10.3390/nu12040884.

119) Klerks, M.; Román, S.; Verkerk, R.; Sanchez-Siles, L. Are cereal bars significantly healthier and more natural than chocolate bars? A preliminary assessment in the German market. J. Funct. Foods 2022, 89, 104940. https://doi.org/10.1016/j.jff.2022.104940.

120) Souiy, Z.; Zakhama, N.; Cheraief, I.; Hammami, M. Nutritional, physical, microbial, and sensory characteristics of gluten-and sugar-free cereal bar enriched with spirulina and flavored with neroli essential oil. LWT 2022, 169, 113955. https://doi.org/10.1016/j.lwt.2022.113955.

121) Mesias, M.; Olombrada, E.; González-Mulero, L.; Morales, F.J.; Delgado-Andrade, C. Investigation on heat-induced chemical indexes in traditional and reformulated biscuits. J. Food Compos. Anal. 2021, 101, 103963. https://doi.org/10.1016/j.jfca.2021.103963.

122) Mozaffarian, D.; El-Abbadi, N.H.; O'Hearn, M.; Erndt-Marino, J.; Masters, W.A.; Jacques, P.; Shi, P.; Blumberg, J.B.; Micha, R. Food Compass is a nutrient profiling system using expanded

characteristics for assessing healthfulness of foods. Nat. Food 2021, 2, 809–818. https://doi.org/10.1038/s43016-021-00381-y.

123) Kupirovič, U.P.; Hristov, H.; Hribar, M.; Lavriša, Ž.; Pravst, I. Facilitating consumers choice of healthier foods: A comparison of different front-of-package labelling schemes using Slovenian food supply database. Foods 2020, 9, 399. https://doi.org/10.3390/foods9040399.

124) Vandevijvere, S.; Berger, N. The impact of shelf tags with Nutri-Score on consumer purchases: A difference-in-difference anal-ysis of a natural experiment in supermarkets of a major retailer in Belgium. Int. J. Behav. Nutr. Phys. Act. 2021, 18, 150. https://doi.org/10.1186/s12966-021-01207-7.

125) Ahn, C.; Lee, C.G. Effect of NUTRI-SCORE labeling on sales of food items in stores at sports and non-sports facilities. Prev. Med. Rep. 2022, 29, 101919. https://doi.org/10.1016/j.pmedr.2022.101919.

126) Drewnowski, A.; Gonzalez, T.D.; Rehm, C.D. Balanced Hybrid Nutrient Density Score Compared to Nutri-Score and Health Star Rating Using Receiver Operating Characteristic Curve Analyses. Front. Nutr. 2022, 9, 867096. https://doi.org/10.3389/fnut.2022.867096.

127) Meisterernst, A.; Evans, L. Union law basis and official controls of the nutri-score®. Eur. Food Feed Law Rev. 2020, 15, 202–211.

128) Pointke, M.; Pawelzik, E. Plant-Based Alternative Products: Are They Healthy Alternatives? Micro- and Macronutrients and Nutritional Scoring. Nutrients 2022, 14, 601. https://doi.org/10.3390/nu14030601.

129) Katsouri, E.; Magriplis, E.; Zampelas, A.; Drosinos, E.H.; Nychas, G.-J. Dietary intake assessment of pre-packed graviera cheese in greece and nutritional characterization using the nutri-score front of pack label scheme. Nutrients 2021, 13, 295. https://doi.org/10.3390/nu13020295.

130) Eykelenboom, M.; Van Stralen, M.M.; Djojosoeparto, S.K.; Poelman, M.P.; Kamphuis, C.B.M.; Vellinga, R.E.; Waterlander, W.E.; Renders, C.M.; Steenhuis, I.H.M. The effects of a sugar-sweetened beverage tax and a nutrient profiling tax based on Nu-tri-Score on consumer food purchases in a virtual supermarket: A randomised controlled trial. Public Health Nutr. 2022, 25, 1105–1117. https://doi.org/10.1017/S1368980021004547.

131) Drewnowski, A. Adjusting for protein quality by food source may affect nutrient density metrics. Nutr. Rev. 2021, 79, 1134–1144. https://doi.org/10.1093/nutrit/nuaa117.

132) Egnell, M.; Boutron, I.; Péneau, S.; Ducrot, P.; Touvier, M.; Galan, P.; Buscail, C.; Porcher, R.; Ravaud, P.; Hercberg, S.; et al. Front-of-pack labeling and the nutritional quality of students' food purchases: A 3-arm randomized controlled trial. Am. J. Public Health 2019, 109, 1122–1129. https://doi.org/10.2105/AJPH.2019.305115.

133) Bryngelsson, S.; Moshtaghian, H.; Bianchi, M.; Hallström, E. Nutritional assessment of plant-based meat analogues on the Swedish market. Int. J. Food Sci. Nutr. 2022, 73, 889–901.

https://doi.org/10.1080/09637486.2022.2078286.

134) Egnell, M.; Boutron, I.; Péneau, S.; Ducrot, P.; Touvier, M.; Galan, P.; Fezeu, L.; Porcher, R.; Ravaud, P.; Hercberg, S.; et al. Impact of the Nutri-Score front-of-pack nutrition label on purchasing intentions of individuals with chronic diseases: Results of a randomised trial. BMJ Open 2022, 12, e058139. https://doi.org/10.1136/bmjopen-2021-058139.

135) Egnell, M.; Galan, P.; Fialon, M.; Touvier, M.; Péneau, S.; Kesse-Guyot, E.; Hercberg, S.; Julia, C. The impact of the Nutri-Score front-of-pack nutrition label on purchasing intentions of unprocessed and processed foods: Post-hoc analyses from three ran-domized controlled trials. Int. J. Behav. Nutr. Phys. Act. 2021, 18, 38. https://doi.org/10.1186/s12966-021-01108-9.

136) Drewnowski, A.; Maillot, M.; Papanikolaou, Y.; Jones, J.M.; Rodriguez, J.; Slavin, J.; Angadi, S.S.; Comerford, K.B. A New Car-bohydrate Food Quality Scoring System to Reflect Dietary Guidelines: An Expert Panel Report. Nutrients 2022, 14, 1485. https://doi.org/10.3390/nu14071485.

137) Voinea, L.; Popescu, D.V.; Negrea, T.M.; Dina, R. Nutrient profiling of romanian traditional dishes—Prerequisite for supporting the flexitarian eating style. Information 2020, 11, 514. https://doi.org/10.3390/info11110514.

138) Konings, J.J.C.; Smorenburg, H.; Roodenburg, A.J.C. Comparison between the Choices Five-Level Criteria and Nutri-Score: Alignment with the Dutch Food-Based Dietary Guidelines. Nutr. Food Sci. Int. J. 2022, 14, 3527.

139) Dongo, D. Front-of-Pack Nutrition Labelling—Legitimacy of Using the Nutri-Score System in EU Member States. Eur. Food Feed Law Rev. 2022, 17, 316.

140) Donini, L.M.; Berry, E.M.; Folkvord, F.; Jansen, L.; Leroy, F.; Şimşek, Ö.; Fava, F.; Gobbetti, M.; Lenzi, A. Front-of-pack labels: "Directive" versus "informative" approaches. Nutrition 2023, 105, 111861. https://doi.org/10.1016/J.NUT.2022.111861.

141) Hercberg, S.; Touvier, M.; Salas-Salvado, J. The Nutri-Score nutrition label: A public health tool based on rigorous scientific evidence aiming to improve the nutritional status of the population. Int. J. Vitam. Nutr. Res. 2022, 92, 147–157. https://doi.org/10.1024/0300-9831/a000722.

142) Martini, D.; Marangoni, F.; Banterle, A.; Donini, L.M.; Riccardi, G.; Poli, A.; Pellegrini, N. Relationship between front-of-pack labeling and nutritional characteristics of food products: An attempt of an analytical approach. Front. Nutr. 2022, 9, 1882. https://doi.org/10.3389/fnut.2022.963592.

143) Strazzullo, P.; Cairella, G.; Sofi, F.; Erba, D.; Campanozzi, A.; Danesi, F.; Iacoviello, L.; Martini, D.; Pellegrini, N.; Rossi, L.; et al. "Front-of-pack" nutrition labeling. Nutr. Metab. Cardiovasc. Dis. 2021, 31, 2989–2992. https://doi.org/10.1016/j.numecd.2021.07.021.

144) Smetana, S.; Profeta, A.; Voigt, R.; Kircher, C.; Heinz, V. Meat substitution in burgers: Nutritional scoring, sensorial testing, and Life Cycle Assessment. Futur. Foods 2021, 4, 100042.

https://doi.org/10.1016/j.fufo.2021.100042.

145) Forner, F.; Volkhardt, I.; Meier, T.; Christen, O.; Stangl, G.I. The nutriRECIPE-Index—development and validation of a nutri-ent-weighted index for the evaluation of recipes. BMC Nutr. 2021, 7, 74. https://doi.org/10.1186/s40795-021-00483-7.

146) Clark, M.; Springmann, M.; Rayner, M.; Scarborough, P.; Hill, J.; Tilman, D.; Macdiarmid, J.I.; Fanzo, J.; Bandy, L.; Harrington, R.A. Estimating the environmental impacts of 57,000 food products. Proc. Natl. Acad. Sci. USA 2022, 119, e2120584119. https://doi.org/10.1073/pnas.2120584119.

147) Abou Jaoudé, L.; Denis, I.; Teyssier, S.; Beugnot, N.; Davidenko, O.; Darcel, N. Nutritional labeling modifies meal composition strategies in a computer-based food selection task. Food Qual. Prefer. 2022, 100, 104618. https://doi.org/10.1016/j.foodqual.2022.104618.

148) Drewnowski, A. Perspective: Identifying Ultra-Processed Plant-Based Milk Alternatives in the USDA Branded Food Products Database. Adv. Nutr. 2021, 12, 2068–2075. https://doi.org/10.1093/advances/nmab089.

149) Deschasaux, M.; Huybrechts, I.; Julia, C.; Hercberg, S.; Egnell, M.; Srour, B.; Kesse-Guyot, E.; Latino-Martel, P.; Biessy, C.; Casa-grande, C.; et al. Association between nutritional profiles of foods underlying Nutri-Score front-of-pack labels and mortality: EPIC cohort study in 10 European countries. BMJ 2020, 370, m3173. https://doi.org/10.1136/bmj.m3173.

150) Gómez-Donoso, C.; Martínez-González, M.Á.; Perez-Cornago, A.; Sayón-Orea, C.; Martínez, J.A.; Bes-Rastrollo, M. Associa-tion between the nutrient profile system underpinning the Nutri-Score front-of-pack nutrition label and mortality in the SUN project: A prospective cohort study. Clin. Nutr. 2021, 40, 1085–1094. https://doi.org/10.1016/j.clnu.2020.07.008.

151) Andrianasolo, R.M.; Julia, C.; Varraso, R.; Egnell, M.; Touvier, M.; Kesse-Guyot, E.; Hercberg, S.; Galan, P. Association between an individual dietary index based on the British Food Standard Agency Nutrient Profiling System and asthma symptoms. Br. J. Nutr. 2019, 122, 63–70. https://doi.org/10.1017/S0007114519000655.

152) Paper, L.; Ahmed, M.; Lee, J.J.; Kesse-Guyot, E.; Touvier, M.; Hercberg, S.; Galan, P.; Salanave, B.; Verdot, C.; L'Abbé, M.R.; et al. Cross-sectional comparisons of dietary indexes underlying nutrition labels: Nutri-score, Canadian 'high in' labels and Dia-betes Canada Clinical Practices (DCCP). Eur. J. Nutr. 2023, 62, 261–274. https://doi.org/10.1007/s00394-022-02978-w.

153) Bullón-Vela, V.; Sayón-Orea, C.; Gómez-Donoso, C.; Martínez, J.A.; Martínez-González, M.A.; Bes-Rastrollo, M. Mortality prediction of the nutrient profile of the Chilean front-of-pack warning labels: Results from the Seguimiento Universidad de Navarra prospective cohort study. Front. Nutr. 2022, 9, 951738. https://doi.org/10.3389/fnut.2022.951738.

154) Egnell, M.; Crosetto, P.; D'Almeida, T.; Kesse-Guyot, E.; Touvier, M.; Ruffieux, B.; Hercberg, S.; Muller, L.; Julia, C. Modelling the impact of different front-of-package nutrition labels on

mortality from non-communicable chronic disease. Int. J. Behav. Nutr. Phys. Act. 2019, 16, 56. https://doi.org/10.1186/s12966-019-0817-2.

155) Julia, C.; Péneau, S.; Buscail, C.; Gonzalez, R.; Touvier, M.; Hercberg, S.; Kesse-Guyot, E. Perception of different formats of front-of-pack nutrition labels according to sociodemographic, lifestyle and dietary factors in a French population: Cross-sectional study among the NutriNet-Santé cohort participants. BMJ Open 2017, 7, e016108. https://doi.org/10.1136/bmjopen-2017-016108.

156) Deschasaux, M.; Julia, C.; Kesse-Guyot, E.; Lécuyer, L.; Adriouch, S.; Méjean, C.; Ducrot, P.; Péneau, S.; Latino-Martel, P.; Fezeu, L.K.; et al. Are self-reported unhealthy food choices associated with an increased risk of breast cancer? Prospective cohort study using the British Food Standards Agency nutrient profiling system. BMJ Open 2017, 7, e013718. https://doi.org/10.1136/bmjopen-2016-013718.

157) Millar, S.R.; Navarro, P.; Harrington, J.M.; Perry, I.J.; Phillips, C.M. Associations between the Nutrient Profiling System Un-derlying the Nutri-Score Nutrition Label and Biomarkers of Chronic Low-Grade Inflammation: A Cross-Sectional Analysis of a Middle- to Older-Aged Population. Nutrients 2022, 14, 3122. https://doi.org/10.3390/nu14153122.

158) Andreeva, V.A.; Egnell, M.; Galan, P.; Feron, G.; Hercberg, S.; Julia, C. Association of the dietary index underpinning the nu-tri-score label with oral health: Preliminary evidence from a large, population-based sample. Nutrients 2019, 11, 1998. https://doi.org/10.3390/nu11091998.

159) Packer, J.; Russell, S.J.; Ridout, D.; Hope, S.; Conolly, A.; Jessop, C.; Robinson, O.J.; Stoffel, S.T.; Viner, R.M.; Croker, H. Assessing the Effectiveness of Front of Pack Labels: Findings from an Online Randomised-Controlled Experiment in a Representative British Sample. Nutrients 2021, 13, 900. https://doi.org/10.3390/nu13030900.

160) Andreeva, V.A.; Egnell, M.; Stoś, K.; Przygoda, B.; Talati, Z.; Touvier, M.; Galan, P.; Hercberg, S.; Pettigrew, S.; Julia, C. Polish Consumers' Understanding of Different Front-of-Package Food Labels: A Randomized Experiment. Foods 2022, 11, 134. https://doi.org/10.3390/foods11010134.

161) Andreeva, V.A.; Egnell, M.; Handjieva-Darlenska, T.; Talati, Z.; Touvier, M.; Galan, P.; Hercberg, S.; Pettigrew, S.; Julia, C. Bul-garian consumers' objective understanding of front-of-package nutrition labels: A comparative, randomized study. Arch. Pub-lic Health 2020, 78, 35. https://doi.org/10.1186/s13690-020-00416-z.

162) Folkvord, F.; Bergmans, N.; Pabian, S. The effect of the nutri-score label on consumer's attitudes, taste perception and purchase intention: An experimental pilot study. Food Qual. Prefer. 2021, 94, 104303. https://doi.org/10.1016/j.foodqual.2021.104303.

163) Goiana-Da-silva, F.; Cruz-E-silva, D.; Nobre-Da-costa, C.; Nunes, A.M.; Fialon, M.; Egnell, M.; Galan, P.; Julia, C.; Talati, Z.; Pettigrew, S.; et al. Nutri-score: The most efficient front-of-pack

nutrition label to inform portuguese consumers on the nutri-tional quality of foods and help them identify healthier options in purchasing situations. Nutrients 2021, 13, 4335. https://doi.org/10.3390/nu13124335.

164) Hutton, T.R.; Gresse, A. Objective understanding of five front-of-pack labels among consumers in Nelson Mandela Bay, South Africa. S. Afr. J. Clin. Nutr. 2022, 35, 108–114. https://doi.org/10.1080/16070658.2021.1991674.

165) Packer, J.; Russell, S.J.; Ridout, D.; Conolly, A.; Jessop, C.; Viner, R.M.; Croker, H. Secondary Outcomes of a Front-of-Pack-Labelling Randomised Controlled Experiment in a Representative British Sample: Understanding, Ranking Speed and Perceptions. Nutrients 2022, 14, 2188. https://doi.org/10.3390/nu14112188.

166) Mazzù, M.F.; Romani, S.; Marozzo, V.; Giambarresi, A.; Baccelloni, A. Improving the understanding of key nutritional ele-ments to support healthier and more informed food choices: The effect of front-of-pack label bundles. Nutrition 2023, 105, 111849. https://doi.org/10.1016/j.nut.2022.111849.

167) Egnell, M.; Talati, Z.; Galan, P.; Andreeva, V.A.; Vandevijvere, S.; Gombaud, M.; Dréano-Trécant, L.; Hercberg, S.; Pettigrew, S.; Julia, C. Objective understanding of the Nutri-score front-of-pack label by European consumers and its effect on food choices: An online experimental study. Int. J. Behav. Nutr. Phys. Act. 2020, 17, 146. https://doi.org/10.1186/s12966-020-01053-z.

168) Mazzù, M.F.; Baccelloni, A.; Romani, S.; Andria, A. The role of trust and algorithms in consumers' front-of-pack labels ac-ceptance: A cross-country investigation. Eur. J. Mark. 2022, 56, 3107–3137. https://doi.org/10.1108/EJM-10-2021-0764.

169) Egnell, M.; Galan, P.; Farpour-Lambert, N.J.; Talati, Z.; Pettigrew, S.; Hercberg, S.; Julia, C. Compared to other front-of-pack nutrition labels, the Nutri-Score emerged as the most efficient to inform Swiss consumers on the nutritional quality of food products. PLoS ONE 2020, 15, e0228179. https://doi.org/10.1371/journal.pone.0228179.

170) Hoge, A.; Labeye, M.; Donneau, A.-F.; Nekoee, H.Z.; Husson, E.; Guillaume, M. Health Literacy and Its Associations with Un-derstanding and Perception of Front-of-Package Nutrition Labels among Higher Education Students. Int. J. Environ. Res. Public Health 2022, 19, 8751. https://doi.org/10.3390/ijerph19148751.

171) Fialon, M.; Egnell, M.; Talati, Z.; Galan, P.; Dréano-Trécant, L.; Touvier, M.; Pettigrew, S.; Hercberg, S.; Julia, C. Effectiveness of different front-of-pack nutrition labels among italian consumers: Results from an online randomized controlled trial. Nutri-ents 2020, 12, 2307. https://doi.org/10.3390/nu12082307.

172) Mazzù, M.F.; Romani, S.; Baccelloni, A.; Gambicorti, A. A cross-country experimental study on consumers' subjective under-standing and liking on front-of-pack nutrition labels. Int. J. Food Sci. Nutr. 2021, 72, 833–847. https://doi.org/10.1080/09637486.2021.1873918.

173) Kontopoulou, L.; Karpetas, G.; Fradelos, E.C.; Papathanasiou, I.V.; Malli, F.; Papagiannis, D.; Mantzaris, D.; Fialon, M.; Julia, C.; Gourgoulianis, K.I. Online consumer survey comparing different front-of-pack labels in Greece. Nutrients 2022, 14, 46. https://doi.org/10.3390/nu14010046.

174) Mazzù, M.F.; Romani, S.; Baccelloni, A.; Lavini, L. Introducing the Front-Of-Pack Acceptance Model: The role of usefulness and ease of use in European consumers' acceptance of Front-Of-Pack Labels. Int. J. Food Sci. Nutr. 2022, 73, 378–395. https://doi.org/10.1080/09637486.2021.1980866.

175) Egnell, M.; Kesse-Guyot, E.; Galan, P.; Touvier, M.; Rayner, M.; Jewell, J.; Breda, J.; Hercberg, S.; Julia, C. Impact of front-of-pack nutrition labels on portion size selection: An experimental study in a French cohort. Nutrients 2018, 10, 1268. https://doi.org/10.3390/nu10091268.

176) Egnell, M.; Talati, Z.; Hercberg, S.; Pettigrew, S.; Julia, C. Objective understanding of front-of-package nutrition labels: An in-ternational comparative experimental study across 12 countries. Nutrients 2018, 10, 1542. https://doi.org/10.3390/nu10101542.

Chapter 4

Is it really a piece of cake to label Geographical Indications with the Nutri-Score? Consumers' behaviour and policy implications

Abstract

To improve the dietary habits of the population, the EU, within the Farm to Fork strategy (F2F), is strongly supporting the Nutri-Score (NS) Front Of Pack (FOP) label. Under the NS system, Geographical Indications (GIs) are generally scored as "unhealthy" food, given the predominance of products of animal origin among GIs which are, notoriously, high-fat products. This study aims to determine the impact of the NS label on consumers' preferences for two Protected Designation of Origin (PDO) cheeses, in comparison with generic ones. A Discrete Choice Experiment (DCE) was conducted on 600 Italian consumers through the estimation of a Random Parameter Logit model. Results highlighted that Italian consumers are generally not familiar with the NS and perceive it as a positive characteristic of the product, even if it is signalling an unhealthy choice (D score). However, consumers aware of the Nutri-Score meaning are willing to pay less to buy a product considered "unhealthy" according to this system. Furthermore, we found that consumers who already knew the NS system have homogeneous behaviours in rejecting the product, independently of the association with a PDO certification. This result has important implications on the agri-food sector. If the Nutri-Score becomes mandatory in the EU, consumers might refuse many GIs due to their negative Nutri-Score values. However, the quality of these products is recognized and protected worldwide. In this vein, the GI policy could be questioned by the F2F strategy: both of them aims to reduce information asymmetry producing, at the same time, contrasting results. Within the Geographical Indication policy, the PDO and PGI goods are protected for their quality attributes, which are strictly linked to their geographical origin of the products and traditional know-how.

However, the EU adoption of the Nutri-Score could damage these products, reducing their perceived quality/value.

4.1 Introduction

Non-Communicable Diseases (NCDs) are one of the key problems of the XXI century. Among the others, obesity is the main nutritional issue, as it registered an increase of 200% between 1975 and 2016 (WHO 2020). As modifiable risk behaviours (e.g., unhealthy diets and physical inactivity) are found to be one of the main causes of NCDs, international authorities are currently adopting policy strategies to improve citizens' dietary behaviours to tackle the issue (Ng et al. 2014).

In this context, informed purchasing choices become a global priority and nutritional labelling has been identified as a crucial aspect in consumer decision making to promote healthier dietary behaviours (Fialon et al. 2020; Hawkes and Popkin 2015), especially in Mediterranean countries (Capacci et al. 2012). However, the literature pointed out that consumers pay little attention to nutritional labels. Indeed, although 40% of consumers state they rely on Back of Pack nutritional labels when purchasing (Delamaire et al., 2008; Donga and Patel, 2018; Sanjar et al., 2012), only 10% actually do so when observed during in-store studies (Grunert et al. 2010). This might be due to the inconspicuous location of nutritional labels on food packaging (Graham et al. 2017), consumers' time constraints when shopping (Grunert et al. 2010), and their limited understanding of the Nutrition Facts (Campos, Doxey and Hammond 2011). It follows that costumers are frequently not able to use this information at the time of purchase. Therefore, a new and easier-to-understand version of nutritional labelling has been widely promoted through Front-Of-Pack (FOP) labels, i.e., graphic labels placed on the front of the package which give concise information about the nutritional profile of the food.

Currently, the EU legislative framework does not regulate FOP nutrition labelling in a harmonized and compulsory way. It follows that multiple FOP schemes co-exist in the European Union (Storcksdieck Gennat Bonsmann et al. 2020). Some of these are promoted by single or groups of countries, such as the Multiple Traffic Lights (MTL) in the United Kingdom and the Green Keyhole in Scandinavian countries. Besides, Reference Intakes (RIs) and summary graded indicators, such as the Nutri-Score, are used by several food manufacturers at EU level.

However, as underlined by Temple (2020), even if many countries have already adopted different FOP labels, their use on food products packages is still voluntary. The food industry takes advantage of this, since they can endorse the use of FOP labels on many products, but decline to use them when these labels could reduce their sales value (Carter et al. 2013). Considering this broad spectrum of FOP labels and their voluntary adoption, the European Commission, within the Farm to Fork strategy, has stressed the need to use a mandatory and self-explanatory Front-Of-Pack nutrition labelling, homogeneous across member states, within 2022.

Among others, the Nutri-Score, tested in a series of experimental and "real-life" studies related to consumers' labels perception (Ducrot et al. 2015a), understanding (Ducrot et al. 2015b) and food purchases (Julia et al. 2016), has proved to be more efficient than other currently available FOP nutritional labels to classify products according to their nutritional quality (Ducrot et al. 2015). The European Committee of the Regions (2018) called on the European Commission to propose the Nutri-Score as a single mandatory labelling system within the EU. Under the FOP philosophy, the Nutri-Score label has two specific objectives. The first one is to provide consumers with summarized nutritional information in a clear and easy-to-understand way, guiding them towards healthier food choices (Talati et al. 2017). The second one appeals to the competition among brands, encouraging the food industry to reformulate their products by improving their nutritional quality, and making them more attractive to consumers (Vyth et al. 2010).

The Nutri-Score FOP label simplifies the identification of the nutritional values of a product conjointly using a chromatic (from green, "healthy", to dark orange, "unhealthy") and an alphabetical scale (from A, "healthy", to E, "unhealthy"). As stressed in the literature, consumers are more able to discriminate against health-related questions about food products in the case of coloured traffic light labels, with respect to other monochromatic ones (Kelly et al. 2009; Borgmeier and Westenhoefer 2009). Moreover, from a biological perspective, dark orange and green are immediately discerned and discriminated by the human eye (Nagle and Osorio 1993).

At EU level, this system is currently adopted, on a voluntary basis, in France (October 2017), Belgium (April 2018), Spain (November 2018), Germany (September 2019), the Netherlands (November 2019), and is under consideration in many other countries. It is not used in Italy, and its adoption is an open debate since opinions on it are still controversial. As a consequence, Italian consumers are not familiar with the Nutri-Score because no products with

this FOP label are present in the Italian market yet. Supporting this, it is worth noting that Italian policy makers have proposed the Nutri-Inform battery as an alternative to the Nutri-Score. However, many authors suggested that the FOP labels effectiveness is strictly correlated with consumers' understanding of the label (Santos et al. 2020). Hence, as underlined by the European Commission, a mandatory and EU-level implementation of FOP labels would require an assessment of their effectiveness, i.e., their ability to produce the expected results (e.g., reducing the information asymmetry to ensure a more informed - and presumably healthier - choice for the consumer) among all the member states.

Within this framework, a literature analysis highlighted that although several papers (see for instance: Ducrot et al., 2015a, 2015b; Julia et al., 2016) have been published that outline the power of Nutri-Score to determine the nutritional value of food, very few studies aimed to understand its impact on consumers' purchasing choices (Mora-García et al., 2019). Furthermore, to assess the efficiency of the Nutri-Score at EU level, it is relevant to consider the impact on the demand for products considered of "low health quality". The Nutri-Score classification is based on the average nutritional value of the product, and it considers, per 100 grams of product, the content of nutrients and foods that should be promoted (fibre, protein, fruits and vegetables, for a maximum of 30 points) and the content of nutrients and food that should be limited (energy, saturated fatty acids, sugars, salt, for a maximum of 40 points)[12]. Due to the high content of calories and saturated fats, products of animal origin will be characterized by a negative score (i.e., a red or orange label). Contrary to what the MTL does, which focuses only on the nutrients that must be limited in a balanced diet (i.e., fats, saturated fats, sugars and salt), the NS evaluates the overall nutritional quality of the products. Therefore, in the NS case, it is the product itself that is not nutritionally valid, not some of its characteristics.

In this framework, Geographical Indications (GI) products seem to be particularly penalized by the Nutri-Score, given the predominance of products of animal origin in this group. In Italy, which is the top EU country in terms of GIs certifications, 9 out of the top 10 GI products by production value are of animal origin (ISMEA 2019) and represent 85% of GI production value and 40% of the national export of products of animal origin. Furthermore, it should be recalled that GI products must follow a strict and traditional product specification and they cannot be easily reformulated to improve their Nutri-Score value. Despite the relevance of this

[12] Specific regulation is available at: https://www.santepubliquefrance.fr/content/download/150258/file/Nutriscore_reglement_usage_EN_310122_VDEF.pdf.

topic, no scientific work has been published to evaluate the impact on consumer preferences of Nutri-Score labels applied on quality products (GI).

In light of this, the present study aims to assess consumers' preferences and their Willingness To Pay (WTP) for Nutri-Score labelled cheeses in Italy (RQ1). We also want to understand if previous knowledge of the label affects the purchasing preferences of the consumers in our sample (RQ2). Then, we want to assess whether the Nutri-Score effect is different on PDO cheeses (RQ3) rather than on generic cheeses. For this purpose, a Discrete Choice Experiment (DCE) was performed on 600 Italian consumers. As consumers familiarity towards different GIs might affect consumers' evaluation of nutritional labels (Velasco Vizcaíno and Velasco 2019), the effect of the GI attribute was estimated using two PDO names with different level of brand familiarity: "Asiago PDO" and "Casatella Trevigiana PDO". The paper is organized as follows: data collection and model specification are provided in the next section. Results are reported in section 4.3 and discussed in section 4.4. Some conclusions are drawn in section 5. Finally, in the last section, the policy implications of the present study are reported.

4.2. Data and methods

4.2.1. Experimental Design

During the spring 2021, a Discrete Choice Experiment was conducted on 600 Italian consumers, aged over 18, to assess the Nutri-Score effect on their preferences for fresh cheeses in Italy.
The survey, administered online by the Norstat panel agency, was organised according to the scheme in Figure 4.1. Specifically, we have two different blocks, because of the definition of the PDO (see section 4.2.2 for more details on this point). In the first block, consumers were presented with an Asiago PDO cheese in comparison with a cheese of the same typology (i.e., fresh cheese of cow milk maturated for at least 20 days) without the Designation of Origin. In the second block consumers are presented with Casatella Trevigiana PDO in comparison with a generic casatella cheese. It should be noticed that, in Italy, the term "casatella" is referred to a specific fresh cheese typology, made of whole cow milk with a ripening period of 4-8 days. Respondents of both blocks assure the representativeness of the data according to the following criteria: geographical, gender and age. Descriptive statistics of the sample are summarized in Table 3.1.

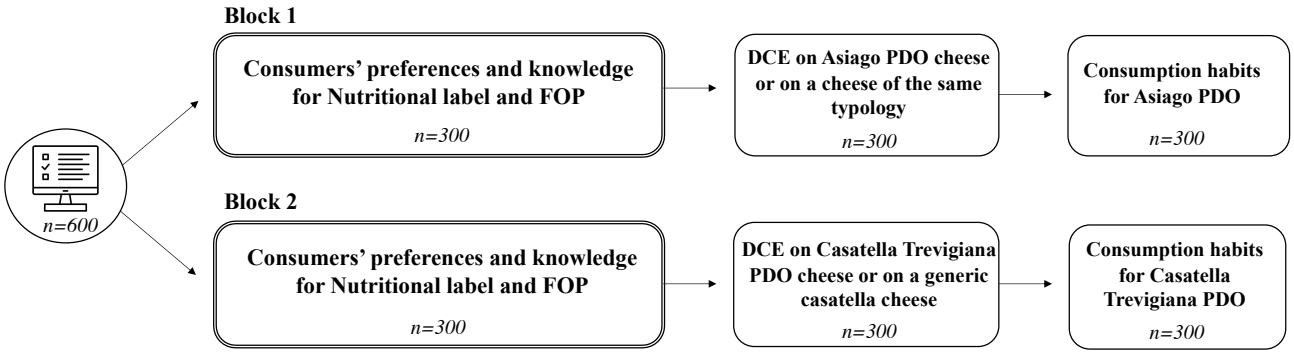

Figure 4.1. Structure of the experiment

Note. The experimental structure is the same in the two blocks. Differences are only found in the product subject of investigation (single line squares).

The first part of the questionnaire was focused on understanding consumers' preferences and knowledge of different types of nutritional and FOP labels, as well as customers' purchasing habits for products with these types of labels. 7-points Likert scales were used to address these objectives. The second part of the survey concerns the DCE (see section 2.2). The final section was about consumers' consumption habits for each type of PDO cheese.

Table 4.1 Descriptive statistics of the sample

		Block 1		***Block 2***		
		Sample population		Sample population		Italian population
Variable	**Levels**	**N. obs**	**%**	**N. obs**	**%**	**%**
Age (years)	18-24	24	8.0	24	8.0	8.00
	25-34	39	13.0	37	12.3	12.7
	35-44	45	15.0	46	15.3	15.3
	45-54	59	19.7	58	19.3	19.3
	55-64	49	16.3	49	16.3	16.7
	over 65	84	28.0	86	28.7	28.0
Gender	female	153	51.0	153	51.0	51.3
	male	147	49.0	147	49.0	48.7
Education level	compulsory	30	10.0	27	9.0	56.0[†]
	upper	169	56.3	164	54.7	26.3[*]
	university	69	23.0	82	27.3	17.4[*]
	post-university degree	32	10.7	27	9.0	0.3[*]

						Mean
Family income (€/month)	less than 2,500	116	38.7	121	40.3	1,627.33* €/month
	about 2,500	137	45.7	146	48.7	
	more than 2,500	47	15.7	33	11.0	
		Mean ± St. Dev.		Mean ± St. Dev.		Weighted mean
Number of household members		2.84	1.15	2.83	1.28	2.35

Note. † In Italy, compulsory schooling is currently not defined by a school cycle, but by reaching the age of 16. Data on compulsory education in Italy are not available on the Eurostat database. Values are estimated.
* Eurostat, 2020. (https://ec.europa.eu/eurostat/data/database).
Source. ISTAT (Italian National Statistics Institute) and Eurostat.

4.2.2. Choice experiment

The attributes of the choice experiment and their respective levels are the same for both blocks, except for the price values, as shown in Table 4.2.

Table 4.2. Description of the CE attributes and levels

	Block 1	***Block 2***	
Attributes	***Levels***	***Levels***	***Code***
PDO name	Asiago PDO	Casatella Trevigiana PDO	(1)
	Absence	Absence	(0)
Nutri-Score	Score D	Score D	(1)
	Absence	Absence	(0)
Price	2.39 €/100g	2.49 €/100 g	
	2.97 €/100g	2.91 €/100 g	
	3.55 €/100g	3.33 €/100 g	

The first attribute taken into account in the experiment is the PDO. Being a Designation of Origin, the PDO sign cannot stand on its own, but it needs to be associated with a registered name. It follows that a specific PDO name needs to be considered in the experiment. However, consumers have different levels of familiarity with different PDO names, or, more precisely, with the different "collective brands" (Herrera and Blanco 2011). Literature stressed that brand familiarity may affect consumers' purchasing choices, since if a familiar brand is present on the package, consumers may attach a lower relevance to the FOP nutritional label, thus reducing

the efficiency of the label itself (Velasco Vizcaíno and Velasco 2019). In this sense, PDO names play a role similar to that of private brands. Indeed, Arfini (1999) found that consumers perceived the PDO names (i.e., the names of the PDO consortia) as more important than the PDO sign itself. Therefore, PDO names could affect the efficiency of the Nutri-Score label.

To solve this issue, we chose to use two PDO names, with a different degrees of consumers' familiarity: Asiago PDO and Casatella Trevigiana PDO. The first is very renown in Italy, being the fourth Italian PDO cheese for market share. The second, i.e., the Casatella Trevigiana PDO, is less known and has a sales value 5 times lower than Asiago PDO cheese. Theoretically, we could have considered a PDO attribute with 3 levels: "No PDO sign", "Asiago PDO", and "Casatella PDO". In practice, since the products look different, this was not feasible as we presented real pictures of the alternatives to the respondents (Figure 4.2), to make the choice experiment closer to a real purchasing situation. It follows that we could not use the same picture to represent the two PDO products and the non-PDO version.

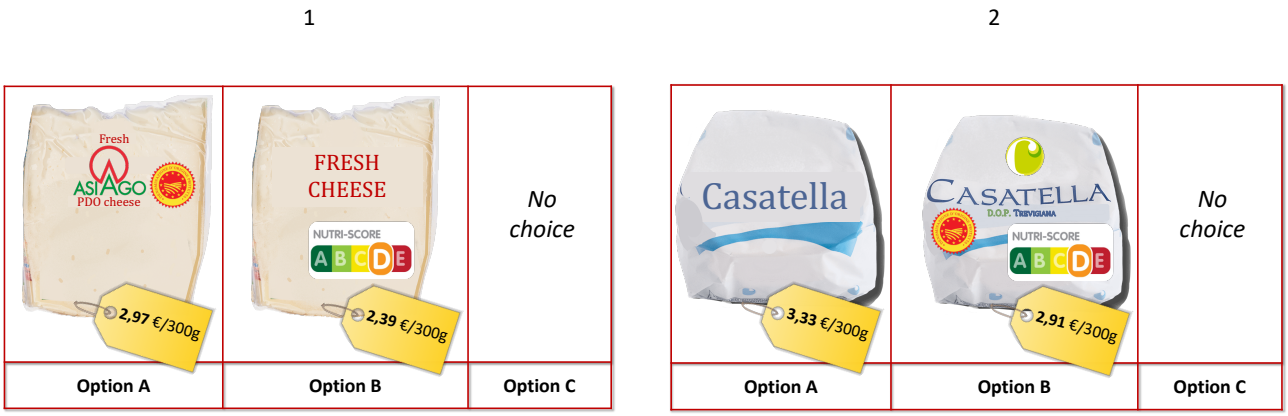

Figure 4.2. Example of a choice set for Block 1 (1) and Block 2 (2)

Note. The original choice tasks are presented to the respondents in Italian. In the figure, terms are translated in English to facilitated the understanding of the readers.

The second attribute considered in the DCE is the Nutri-Score. It was considered as a dummy variable and takes value 1 if this FOP label is present on the product package, 0 otherwise. There is no variance within the Nutri-Score level in this DCE, since, according to the Nutri-Score nutrient profiling system[13], both case studies would be considered as "unhealthy" (score D - orange label). Indeed, Asiago PDO cheese is made of full-cream cow's milk and it has

[13] For specification about the Nutri-Score alghortim see: https://www.santepubliquefrance.fr/en/nutri-score

366 Kcal per 100 g and 24 g of saturated fats. Similarly, the Casatella Trevigiana PDO has 273 Kcal and 23g of saturated fats. It should be noted that the case studies selected in the present analysis are representative of the major GI cheeses in terms of Nutri-Score levels for production values. Table A.1. reports a list of the top 20 Italian PDO cheeses ordered by production value and their respective Nutri-Score levels. All the cheeses obtained a "D" value, according to this profiling system, except for Parmigiano Reggiano, Grana Padano, and Caciocavallo Sillano, which obtained the worst score (letter E). Lastly, the price levels were selected based on the current market prices and estimated prices retrieved both from the retail market and online (https://www.miaspesa.it/search) for both products. Price was considered as a continuous variable in the model.

The choice experiment was generated using the R `idefix` package (Traets, Sanchez and Vandebroek 2019), which used a Modified Federov algorithm to search for efficiency design for discrete choice experiments, based on the multinomial logit model estimates derived from a pilot study conducted on 136 Italian consumers. 12 choice sets were generated, which are thus split into two groups. Six choice sets are therefore assigned to each respondent. Each choice set is represented by two product alternatives (A and B), with different levels of the selected attributes, and a third option (C) that is a no-choice option (Figure 2). The last alternative guarantees a realistic purchasing scenario: in this way, according to Hensher et al. (2005), a consumer can choose not to buy the good if its characteristics do not satisfy him/her. A Random Parameter Model (RPL), which is theoretically explained in the next section, was estimated to assess consumer preferences for Nutri-Score labelled GIs cheeses.

4.2.3. Theoretical explanation of the model and model specification

The DCE method is based on the Random Utility Theory (McFadden, 1973), which assumes that a consumer, among the different possibilities provided, chooses the alternative that guarantees him/her the highest utility. According to Lancaster (1966), the utility that a consumer derives from buying a product is not related to the product itself, but to the bundle of its attributes, while, according to McFadden (1973), the utility is the sum of an observable component and a random error (unobservable) term.

Although the levels of the attributes of each alternative can be observed, the individuals' preferences cannot be directly detected. To assess consumers' preferences expressed through

DCE, the McFadden (1973) Multinomial Logit (MNL) model is generally adopted, assuming the homogeneity in consumers' preferences. However, consumers are assumed to differ in their preferences. Hence, the Random Parameter Logit (RPL) model is implemented in this paper to overcome this restriction (Revelt and Train 1998). The utility function for the RPL model is described as:

$$U_{nit} = \beta_n' x_{nit} + \varepsilon_{nit} \tag{4.1}$$

where β_n is a vector of coefficients specific of the individual n and x_{nit} is a vector of observed attributes that are related to individual n and alternative i on choice occasion t. Given the β_n and x_{nit} vectors in (3.1), the probability that the nth consumer chooses alternative i within a set of j alternatives can be expressed as:

$$P_{ni} = \int \frac{exp\,(\beta' x_{ni})}{\sum_j exp\,(\beta' x_{nj})}\, f(\beta|\theta) d\beta \tag{4.2}$$

where $f(\beta|\theta)$ is the density distribution of the β coefficient and θ are the parameters of the distribution (Train 2009).

Given this framework, in both case study analyses, three different RPL models were estimated (Figure 4.3) to address the research questions.

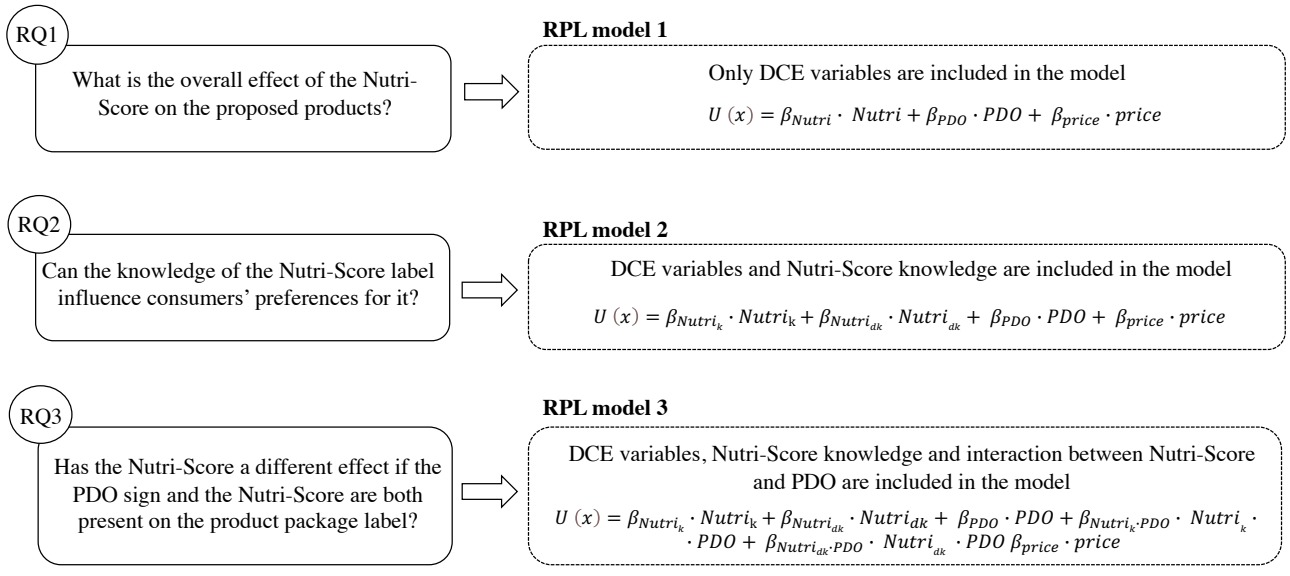

Figure 4.3. Model specification

Note. Research questions are reported within the continuous line figures. Specifications of the models that allow to address the RQs are shown, respectively, in the dashed line figures.

As shown in Figure 4.3, the first model allows the general effect of the Nutri-Score label on Italian consumers' preferences for the proposed cheeses to be assessed. No additional information about what this FOP label is and how it works were provided to consumers. The Nutri-Score being a novelty in Italy, we assumed that previous knowledge of the Nutri-Score could change consumers' perceptions of the proposed products. For this reason, a second RPL model was estimated. The Nutri-Score variable has been replaced with two different variables ($Nutri_k$ and $Nutri_{dk}$). Specifically, $Nutri_k$ takes value 1 if the Nutri-Score label is present in the choice alternative and the n^{th} consumer knows it, 0 otherwise. On the contrary, $Nutri_{dk}$, takes value 1 if the Nutri-Score label is present in the choice alternative and the n^{th} consumer doesn't know it, 0 otherwise. Finally, to highlight the effect of Nutri-Score on PDO cheeses, a third model was employed. To this end, interactions between Nutri-Score and PDO were considered in the model ($PDO*Nutri_k$; $Nutri_{dk}$).

4.3 Results

In the following subsection, some descriptive statistics are given to contextualize consumers' consumption habits for the proposed case studies. In addition, consumers' preferences and knowledge of nutritional and FOP labels are reported in Table 3.3. Results from the estimation of the models are then reported in sections 3.3.1. and 3.3.2.

4.3.1. Consumers' habits

In line with their market shares, we found that 89.84% of consumers already knew the Asiago PDO (fresh type) before filling in the DCE; on the contrary, only 22.52% of the consumers in our sample knew the Casatella Trevigiana PDO. Furthermore, we found that consumers' evaluation of the proposed PDO cheeses changed based on their knowledge of the products (Table 3.3). This is particularly true for the Casatella Trevigiana PDO, for which all the variables investigated in the pair comparison are significantly different between consumers who know the product (*Mean_k*) and those who don't (*Mean_dk*). Specifically, we found that consumers who know the product are more likely to buy it based on its taste, for both cheeses (*Taste*). The same goes for the alleged healthiness of the product (*Healthiness*). However, we interestingly found that consumers who know the Casatella Trevigiana PDO are less prone to buy it than those who don't, since they believe it has a higher calorie (*Calories*) and saturated fat content

(*Content of fat*). This is not true for the Asiago PDO case, considering that no differences are found for these variables between the two subgroups of consumers.

Table 4.3. Pair comparison of purchase (or not purchase) reasons between consumers who know the product (*Mean_k*) and those who don't (*Mean_dk*)

		Fresh Asiago PDO			Casatella Trevigiana PDO		
		Mean_k	*Mean_dk*	*p-value*	*Mean_k*	*Mean_dk*	*p-value*
Intention to buy due to:	Taste	5.81	4.26	0.000	5.90	4.63	0.000
	Healthiness	4.91	3.81	0.000	5.26	4.26	0.000
Intention not to buy due to:	High Calories	3.84	3.81	0.657	4.38	3.39	0.000
	High Content of fat	3.90	3.94	0.676	4.25	3.65	0.000

Note. Consumers are asked to express their intention to buy/not to buy the proposed products based on the attributes reported in the table. The scale measure is 1 = totally disagree; 7 = totally agree.

Table 4.4. shows consumer's habits and their knowledge of nutritional and FOP labels. We found that consumers generally declare to consult both the back-package and the front-package nutritional labels, trusting in the European regulation governing products labelling. Among the existing FOP, Multiple Traffic Light (23.29%) and Daily Reference Intake (31.35 %) are the best known by the consumers in our sample. On the contrary, only 12.45% of respondents declare to be familiar with the Nutri-Score. Furthermore, we found that, when shopping, consumers mainly rely on nutritional information, price and list of ingredients among the elements reported on the label.

Table 4.4. Likert scale measuring consumers' shopping habits for nutritional labelling

Scale items	Mean	St. Dev
Attitudes towards nutritional label (Cronbach's Alpha = 0.79)*		
Generally, I don't have much time to read the labels when shopping	3.31	1.89
Too much information on the label confuses me	3.36	1.90
Nutrition labels on the back of the pack are difficult for me to interpret	3.72	1.76
Consumption habits for nutritional label (Cronbach's Alpha = 0.78)*		
Generally, when shopping, I pay attention to the information on the front of the pack	5.47	1.35
Generally, when shopping, I pay attention to the information on the back of the pack	5.13	1.59
Generally, when shopping, I pay attention to FOP labels, i.e., to the graphical information placed on the front of the pack, which allow consumers to make quick choices.	4.69	1.80
Attitudes towards information provided on the label (Cronbach's Alpha = 0.90)*		
When shopping, how important to you are the following elements reported on the label?		
Nutritional values	5.48	1.36
Price	5.50	1.29
Expiry date or minimum durability date	5.85	1.18
Quantity (grams)	5.53	1.29

Servings per pack	5.02	1.49
Brand	5.14	1.38
Cooking instruction	4.87	1.57
List of ingredients	5.71	1.35
Nutritional claims	5.53	1.36
Health claims	5.33	1.44
Organic certification	5.16	1.65
Environmental sustainability	5.27	1.49
Ethical concern	4.97	1.65
Origin	5.87	1.29
Allergens	5.13	1.72
Trust (Cronbach's Alpha = 0.72)*		
I trust information provided on the label (Reg. EU 1169/2011)	5.42	1.17
I trust information given in food advertising	4.44	1.48
I trust information given by the EFSA	5.10	1.36

Note. * The scale measure is 1 = totally disagree; 7 = totally agree. Descriptive statistics are performed on the whole sample (n= 600).

4.3.2. Choice experiment results

4.3.2.1. Block 1 (Asiago PDO and generic cheese of the same typology)

Three models were estimated to address the research questions (Figure 4.3.). The model estimates are reported in Table 4.5 and the relative estimates of consumers' Willingness To Pay in Table 4.7. Almost all the coefficients are significant at the 5% level. In the three models, the random parameters are assumed to be normally distributed. Price and interaction variables are considered as fixed (Ubilava and Foster 2009).

Table 4.5. Model estimates for the Fresh Asiago PDO and generic cheese of the same typology case study

	Model 1		**Model 2**		**Model 3**	
Random parameter						
PDO	2.778 (0.535)	***	2.673 (0.438)	***	2.684 (0.453)	***
Nutri-Score	1.492 (0.215)	***				
$Nutri_k$			-1.256 (0.197)	***	-1.253 (0.212)	***
$Nutri_{dk}$			1.577 (0.258)	***	1.605 (0.257)	***

Non-Random parameter						
Price	-0.162 (0.036)	***	-0.159 (0.035)	***	-0.166 (0.037)	***
PDO* $Nutri_k$					-0.099 (0.308)	n.s.
PDO* $Nutri_{dk}$					-0.240 (0.268)	n.s.
Derived standard deviation of random parameter						
PDO	2.332 (0.770)	***	2.253 (0.653)	***	2.108 (0.700)	***
Nutri-Score	2.147 (0.613)	***				
$Nutri_k$			0.610 (1.139)	n.s.	0.841 (0.993)	n.s.
$Nutri_{dk}$			2.389 (0.652)	***	2.228 (0.694)	***
Number of respondents	300		300		300	
Number of Obs.	5400		5400		5400	
Log-likelihood	-1468.7509		-1468.1759		-1467.7744	
McFadden pseudo R^2	0.269		0.270		0.270	

Note. * Significance at 10% level; ** Significance at 5% level; *** Significance at 1% level. Standard errors in parentheses.

Model 1 (McFadden pseudo R^2 = 0.269) allows the overall consumer perception of the Nutri-Score label to be understood. Only the DCE variables are considered in the model. From the results it emerged that both the PDO (β_{PDO} = 2.778) and Nutri-Score ($\beta_{Nutri\text{-}Score}$ = 1.492) are, on average, perceived as positive features of the product, despite the Nutri-Score classifying the proposed product as unhealthy. The standard deviation of the Nutri-Score parameter ($\sigma_{Nutri\text{-}Score}$) being statistically different from zero, we can assess, based on the Hole (2007) calculation, that 24% of consumers in the sample attached a negative value to the Nutri-Score attribute. To better characterize this latter subsection of consumers, in **Model 2** (McFadden pseudo R^2 = 0.270) we measured if previous knowledge of the Nutri-Score has a significant effect on consumers' preferences, thus changing their perception of the Nutri-Score variable. We found that consumers who knew the Nutri-Score label attached a negative value (β_{Nutrik}= -1.256) to the presence of this FOP on the pack. On the contrary, consumers that didn't know the Nutri-Score label were most prone to buy a product with a Nutri-Score label (β_{Nutrik}= 1.577), despite having a negative score (unhealthy product), compared to a product without the Nutri-Score label.

Furthermore, from the magnitude of the standard deviation (σ_{Nutrik}*= 0.610)*, it can be understood that consumers who know the Nutri-Score behave similarly (i.e., the coefficients didn't deviate much from the mean value). There being small variability within individuals'

behaviours in this group ($Nutri_k$), it can be said that all consumers attribute a negative value to a product labelled with the Nutri-Score (D score - orange label). On the contrary, consumers who didn't knew the Nutri-Score label have a more heterogeneous attitude towards the Nutri-Score.

Finally, the interaction effect of Nutri-Score and PDO on GI cheeses was estimated in **Model 3**. Results showed that the interaction between PDO and Nutri-Score ($\beta_{PDO*Nutrik}$ = -0.099; $\beta_{PDO*Nutridk}$ = -0.240) were not significantly different from 0. Therefore, the presence of both attributes does not reduce the value perceived by consumers to each attribute.

4.3.2.2. Block 2 (Casatella Trevigiana PDO and generic casatella cheese)

As for the block 1, the same models were estimated to answer the RQs about consumers' preferences for the Casatella Trevigiana PDO and a generic casatella. In addition to these, another model (Model 4) was estimated in this case study analysis to better discuss the results as further explained below. The model estimates are reported in Table 4.6 and the relative estimates of consumers' Willingness To Pay in Table 4.7. Almost all the coefficients are significant at 5%, except for some interactions in Model 4. The random parameters are assumed to be normally distributed, according to the RPL model assumption. Price and interaction variables are considered as fixed.

Table 4.6. Model estimates for the Casatella Trevigiana PDO and generic casatella cheese case study

	Model 1		**Model 2**		**Model 3**		**Model 4**	
Random parameter								
PDO	1.735	***	1.642	***	1.712	***	1.761	***
	(0.300)		(0.250)		(0.227)		(0.239)	
Nutri-Score	0.832	***						
	(0.121)							
$Nutri_k$			-0.994	***	-1.181	***	-1.197	***
			(0.260)		(0.283)		(0.284)	
$Nutri_{dk}$			0.768	***	0.991	***	0.996	***
			(0.119)		(0.116)		(0.119)	
Non-Random paramter								
Price	-0.095	***	-0.092	***	-0.150	***	-0.146	***
	(0.031)		(0.030)		(0.033)		(0.033)	
$PDO*Nutri_k$					0.719	**		
					(0.315)			
$PDO*Nutri_{dk}$					-0.659	***		

					(0.172)			
PDO* $Nutri_k$ *$Casatella_k$							0.702	n.s.
							(0.453)	
PDO* $Nutri_k$ * $Casatella_{dk}$							0.872	**
							(0.422)	
PDO* $Nutri_{dk}$ *$Casatella_k$							-0.698	**
							(0.283)	
PDO* $Nutri_{dk}$ *$Casatella_{dk}$							-0.628	***
							(0.185)	
Derived standard deviation of random paramter								
PDO	1.591	**	1.421	**	0.908	n.s.	1.137	*
	(0.670)		(0.588)		(0.658)		(0.598)	
Nutri-Score	1.566	***						
	(0.457)							
$Nutri_k$			1.882	**	2.175	***	2.123	***
			(0.817)		(0.717)		(0.740)	
$Nutri_{dk}$			1.266	***	0.597	n.s.	0.711	n.s.
			(0.468)		(0.648)		(0.607)	
Number of respondents	300		300		300		300	
Number of Obs.	5400		5400		5400		5400	
Log-likelihood	-1662.6273		-1663.3809		-1650.6353		-1651.8819	
McFadden pseudo R^2	0.165		0.164		0.171		0.170	

Note. * Significance at 10% level; ** Significance at 5% level; *** Significance at 1% level. Standard errors in parentheses.

Model 1 (McFadden pseudo R^2 = 0.165) summarizes the overall perceptions of consumers about Nutri-Score labelled cheeses. As found for the block 1, consumers attached a positive value to the PDO sign (β_{PDO} = 1.735), which is a quality cue of the product. The same goes for the Nutri-Score ($\beta_{Nutri\text{-}Score}$ = 0.832), despite having a negative score and signalling an unhealthy product. However, from the magnitude of the standard deviation (σ_{Nutri} *= 1.56)*, it emerged that 30% of consumers in this sample are not prone to buy a cheese labelled with the Nutri-Score (letter D).

In **Model 2** (McFadden pseudo R^2 = 0.164) we try to understand if previous knowledge of the Nutri-Score can influence consumers' perception about this FOP label. As for the block 1, we found that consumers who already knew the Nutri-Score attached a negative value (β_{Nutrik}= -1.504) to this label. However, unlike in the case of Asiago PDO and a generic cheese of the same typology, we found that behaviour of the consumers in this subgroup is not homogeneous. Indeed, 30% of consumers who knew the Nutri-Score (σ_{Nutrik}*= 1.882)* were more prone to buy a product labelled with the Nutri-Score (letter D – orange label) than a product without it. In **Model 3** (McFadden pseudo R^2 = 0.171) the effect of the Nutri-Score on PDO cheese was tested. As opposed to what was found for the block 1, it emerged that the interaction between Nutri-

Score and PDO is significantly different from 0, both for those consumers who already knew the Nutri-Score and for those who didn't. It means that having both the Nutri-Score and PDO sign on the label alters consumers' perception of these attributes. Specifically, we found that consumers who know the Nutri-Score label attached an additional positive value to a product which has both the Nutri-Score and PDO signs, reducing the negative effect of the Nutri-Score.

The opposite effect is estimated when the consumers do not know the Nutri-Score. In **Model 4** (McFadden pseudo $R^2 = 0.170$), it was investigated whether this result is linked to less familiarity of consumers with the Casatella Trevigiana PDO with respect to the Asiago PDO (see Section 3.1). For this purpose, in this model we included interactions among consumers' familiarity with the Casatella PDO ($Casatella_k$), PDO sign, and Nutri-Score label. We found that, for consumers familiar with Casatella Trevigiana PDO and with the Nutri-score ($\beta_{PDO*Nutrik*Casatellak} = 0.702$), the combined effect of Nutri-Score and PDO was not significantly different from zero, as found for the Asiago PDO. This means that consumers evaluate these attributes (Nutri-Score and PDO) similarly, both when they are labelled separately as well as when they are both on the package. Moreover, from the model estimates, it emerged that consumers not familiar with the Casatella Trevigiana PDO, but who are aware of the Nutri-Score system, reduced their negative attitude towards the Nutri-Score $\beta_{PDO*Nutrik*\ Casatelladk} = 0.872$) if the product also carries the PDO logo. On the other hand, we found that for consumers who didn't know the Nutri-Score, the joint effect of the PDO and Nutri-Score was significantly different from the effect of these attributes taken individually. Basically, the Nutri-Score, *per se* ($\beta_{Nutridk} = 0.996$), had a positive effect, as well as the PDO designation ($\beta_{PDO} = 1.761$). The synergistic effect of these two attributes is negative, regardless of whether consumers know Casatella Trevigiana PDO ($\beta_{PDO*Nutridk*\ Casatellak} = -0.698$) or not ($\beta_{PDO*Nutridk*\ Casatelladk} = -0.628$).

Table 4.7. Marginal Willingness To Pay (WTP) for CE attributes (€/300 g of cheese)

	WTP of the consumers in Block 1			***WTP of the consumers in Block 2***			
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
PDO	17.15	16.78	16.18	18.25	17.86	11.44	12.03
Nutri-Score	9.21			8.75			
Nutri_k		-7.89	-7.56		-10.80	-7.89	-8.18
Nutri_dk		9.90	9.67		8.35	6.62	6.81
PDO*Nutri_k						4.80	
PDO*Nutri_dk						-4.40	
PDO*Nutri_k*Casatella_k							
PDO*Nutri_k* Casatella_dk							5.96
PDO*Nutri_dk*Casatella _k							-4.77
PDO*Nutri_dk *Casatella_dk							-4.29

Note. Marginal WTP are shown only for significant variables from RPL models.

4.4. Discussion

The results from our experiment were unexpected. Interestingly, we found that, on average, the consumers in our sample showed a positive WTP for the Nutri-Score label, despite its signalling an "unhealthy" product (both the case studies in our experiment gain a Nutri-Score value equal to D, "unhealthy"). However, if consumers were discriminated based on their previous knowledge of the Nutri-Score, a polarisation of the preferences emerged. Specifically, when consumers already knew the Nutri-Score system, their attitudes towards the D value of Nutri-Score results in a negative WTP ($Nutri_k$) in both the case studies, as reported in Table 3.7. Furthermore, from the magnitude of the standard deviation of the parameter ($Nutri_k$), we found that consumers more aware of the Nutri-Score system behaved similarly to each other. On the contrary, consumers who didn't know the Nutri-Score maintained a heterogeneous behaviour towards this label. Our results are in contrast with previous studies (Julia et al. 2017; Egnell, Kesse-Guyot, et al. 2018) and questions the ability of the Nutri-Score to be self-explanatory, as it sets out to be. As pointed out by Santos et al. (2020), the reasons behind this result could be sought in the way nutritional information is reported. Indeed, the Nutri-Score does not provide the nutrient-specific composition of the product. It follows that, without additional explanation of how it should be interpreted, the absence of this information can make this FOP label less intuitive at first sight.

Furthermore, as the Nutri-Score is not used yet in Italy, consumers are not familiar with this label. This partially explained why Italian consumers don't have an established behaviour towards the Nutri-Score label. Indeed, only a small group of consumers know the Nutri-Score well enough to make conscious purchasing choices. Our results are consistent with Santos et al. (2020) statement: the effectiveness of the FOP label is context-dependent because consumers usually prefer the FOPs previously implemented, at the expense of the new ones, due to familiarity with them. For instance, despite recent studies pointing out that Nutri-Score (Julia et al. 2016; Egnell, Ducrot, et al. 2018) and Health Star Rating system (Neal et al. 2017) are the most effective in guiding healthier food choices, Multiple Traffic Light Label (MTL) is found to be the best option to support Portuguese consumers' healthier purchasing choices, due to the greater familiarity with it (Santos et al. 2020).

In broad terms, it can be assumed that each country prefers a specific FOP label, which consumers in that country are more akin to. However, using different FOP labels across the EU is exactly what the EU try to avoid, considering that the "Farm to Fork" Strategy stressed the

need to have a harmonized FOP label among the European Countries within 2022. In our paper, we found, coherently with Fialon et al. (2020), that Italian consumers know MTL better (or the monochromatic version, namely the Guideline Daily Amounts) than the other FOP labels. On the contrary, the literature underlined that the Nutri-Score is more appreciated by French consumers (Julia et al. 2016); this is unsurprising, given that France is the "motherland" of this label. In light of this, it is worth noting that the majority of scientific papers focused on the Nutri-Score have been produced in France. Hence, mandatory and EU-level implementation of the Nutri-Score label needs an effective assessment among all the Member States, especially in those in which consumers are less familiar with the label. Alternatively, a more in depth analysis need to be carried out among the Member States to determine which labelling system (or which couple of labels) achieves the EU objectives (i.e., helping consumers to make healthier food choices) in the most effective and efficient way. Medina-Molina and Pérez-González (2021), for instance, supports the double use of a summary FOP label (as Nutri-Score) and nutrient-specific ones, as the presence of both of them improves the ability of consumers to choose the healthier options. Once this information gap is filled, the European Commission could evaluate all the proposed labels and choose the best one to adopt.

Furthermore, when more quality attributes are considered, we found that for the less known good, such as the Casatella Trevigiana PDO, prior knowledge of the product is a discriminating factor in consumers' attitude towards Nutri-Score. Indeed, consumers who knew the Nutri-Score label, but were not familiar with the Casatella Trevigiana PDO, positively evaluated a product which had both the PDO designation and Nutri-Score (letter D). This result is at odds with what has been found so far: consumers in this segment are willing to pay 8.18€ less for a product with the Nutri-Score and 12.03€ more for having guaranteed a PDO sign on the pack. However, the presence of both these cues reduced the negative effect of the Nutri-Score by 5.96€ (WTP $_{PDO*Nutri\_k*\ Casatella\_dk}$). This might be due to the information asymmetry on product characteristics. Indeed, we found that consumers who didn't know the Casatella Trevigiana PDO before filling in the survey evaluated this cheese as less caloric and fat than those who knew it previously. When evaluating the healthiness of foods, consumers often make errors, wrongly estimating the calories content, for instance (Chandon and Wansink 2007). To overcome this issue, they often rely on product labels to infer food healthiness. However, Schneider and Ghosh (2020), found that prior belief in the healthiness of the product (or brand) can alter consumers' trust in FOP labels. It follows that the consumers in this segment, believing that they are dealing with a fresh and low-fat cheese, might not have placed too much trust in

the Nutri-Score level that was in contrast with their beliefs. Moreover, in some cases, price and consumption habits might have a greater impact than FOP labels on adjusting consumers' behaviour towards healthier alternatives, according to Boztuğ et al. (2015).

4.5. Conclusions

The present work aims to understand consumers' preferences for cheeses labelled with Nutri-Score, depending on the presence of the Designation of Origin in Italy. Despite assessing the efficiency of the labelling systems being of primary importance to achieve the EU objectives (Pomeranz et al. 2019), to date there are not enough studies supporting the compulsory adoption of the Nutri-Score label. Indeed, to the best of our knowledge, this is the first attempt to assess consumers' attitudes towards GI products labelled with this specific FOP. Interestingly, we found that consumers are on average more prone to buy a product labelled with the Nutri-Score – although the "D" score displayed in the experiment should inform about its negative health features – than a product without this label. Ignoring its meaning, consumers might deem that an additional logo on the label (Nutri-Score) could be a sign of product quality.

However, when consumers are aware of its meaning, they change their preferences, drastically reducing their WTP for a product labelled with "D" score in the FOP. Furthermore, we found that consumers belonging to this latter segment display a homogeneous behaviour towards the Nutri-Score, expressing their unanimous rejection of a product considered to be of low nutritional quality, independently of its association with a PDO certification. This result has important implications on the agri-food sector, especially in the field of GI, and allows consumer behaviour to be "forecast". When the Nutri-Score becomes mandatory among all the EU countries and consumers are more familiar with this labelling, their consumption habits may move in the direction of refusing GI cheeses, in favour of "healthier" substitutes, such as industrial and processed or reformulated foods (Vyth et al., 2010). This would result in a presumable reduction in the sales value of these products, which are one of the pillars of the quality policy for the food sector in the EU. As reported by Hafner and Pravst (2021), the application of the NS on cheeses is a concern in many countries. Indeed, only a few of these products (generic cheeses and not PDO products) can have a positive NS (grade A or B) and, consequently, consumers may consider cheeses as unhealthy foods. However, it is commonly known that high-fat products should be consumed in moderation, thus the lack in the variability

of grade of the NS in this category could create misunderstanding among consumers and could negatively affect the sales of the products.

In this context, it is worth to notice that 90% of the top ten Italian GI products for sales value are going to be branded as products to be avoided (score E) or reduced in consumption (score D). This is due to the oversimplification of the Nutri-Score system (Talati et al. 2019), which restricts the concept of food quality only to the macronutrients of the product, especially if compared with the complexity of the quality concept behind the GI concept. Against this background, the Farm to Fork strategy seems to be at odds with the EU GI policy (Reg. 1151/2021). Within the Geographical Indication policy, the PDO and PGI products are protected for their quality attributes, which are strictly linked to their geographical origin and traditional know-how. However, the EU adoption of the Nutri-Score could damage these products. As found in our paper, the PDO logo doesn't have a halo effect (Thorndike 1920) on the general evaluation of the quality of the product, as, on average, consumers don't behave differently when the Nutri-Score is present on the package together with the PDO sign rather than when products are devoid of the Quality Certification. This result strengthens what was stated before: promoting two different and contrasting policies of quality (GI policy and the Farm to Fork strategy) at the same time is like having your cake and eating it.

In conclusion, our results, albeit preliminary, allow us to question the efficiency of the Nutri-Score in guiding consumers' purchasing choices within the general framework of EU food policies. Considering that, in our study, the desired effect (i.e., orienting consumers towards healthier choices) is reached only among those consumers who already knew what the Nutri-Score is and how it works, we can assume that this labelling is not self-explanatory. Therefore, it needs a wider efficiency and efficacy assessment and information effort among the Member States. Further studies are thus needed on this topic to understand whether additional information on the Nutri-Score modifies consumers' purchasing preferences and about the best information strategy to support a coherent EU food policy for quality, health, and rural development. Besides, testing the effect of the NS on GI products compared to other FOPs should be important to address the European Commission' request.

4.6. Limitations:

In our study, it was considered only one level of the Nutri-Score (letter D). This could be considered a limitation, since results of the present study cannot be extended for those

products bearing a positive Nutri-Score value. However, our choice reflects the real condition of GI cheeses, all of which would receive a negative Nutri-Score value. Furthermore, considering that the sample is representative of the Italian population only in terms of age, gender and geographical area, the results have limited external validity. Non-Italian consumers, with a different familiarity with the label, may behave differently.

References:

Arfini, F. 1999. "The value of typical products: the case of Prosciutto di Parma and Parmigiano Reggiano cheese." In *The Socio-Economics of Origin Labelled Products: Spatial, Institutional and Co-ordination Aspects*. pp. 78–97. Available at: http://ageconsearch.umn.edu/record/241032/files/Arfini _1999_ The value of typical products.pdf.

Borgmeier, I., and J. Westenhoefer. 2009. "Impact of different food label formats on healthiness evaluation and food choice of consumers: A randomized-controlled study." *BMC Public Health* 9(1):1–12. Available at: http://www.biomedcentral.com/1471-2458/9/184 [Accessed June 21, 2021].

Boztuğ, Y., H.J. Juhl, O. Elshiewy, and M.B. Jensen. 2015. "Consumer response to monochrome Guideline Daily Amount nutrition labels." *Food Policy* 53:1–8.

Campos, S., J. Doxey, and D. Hammond. 2011. "Nutrition labels on pre-packaged foods: A systematic review." *Public Health Nutrition* 14(8):1496–1506.

Capacci, S., M. Mazzocchi, B. Shankar, B. Macias, W. Verbeke, F. Ja Pérez-Cueto, A. Kozioł-Kozakowska, B. Piórecka, B. Niedzwiedzka, D. D'addesa, A. Saba, A. Turrini, J. Aschemann-Witzel, T. Bech-Larsen, M. Strand, L. Smillie, J. Wills, and B. Traill. 2012. "Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness." *Nutrition reviews* 70(3):188–200. Available at: https://academic.oup.com/nutritionreviews/article/70/3/188/1904440.

Carter, O., B.W. Mills, E. Lloyd, and T. Phan. 2013. "An independent audit of the Australian food industry's voluntary front-of-pack nutrition labelling scheme for energy-dense nutrition-poor foods." *European Journal of Clinical Nutrition* 67:31–35. Available at: www.nature.com/ejcn.

Chandon, P., and B. Wansink. 2007. "The biasing health halos of fast-food restaurant health claims: Lower calorie estimates and higher side-dish consumption intentions." *Journal of Consumer Research* 34(3):301–314.

Delamaire, C., C. Bossard, and C. Julia. 2008. "Perceptions, connaissances et attitudes en matière d'alimentation." In *Baromètre santé nutrition 2008*. pp. 80–116.

Donga, G., and Patel, N. 2018. "A review of research studies on factors affecting consumers' use of nutritional labels". International Journal of Food Sciences and Nutrition, 7(3), 555713.

Ducrot, P., C. Méjean, C. Julia, E. Kesse-Guyot, M. Touvier, L. Fezeu, S. Hercberg, and S. Péneau. 2015(a). "Effectiveness of Front-Of-Pack Nutrition Labels in French Adults: Results from the NutriNet-Santé Cohort Study." *PLoS One,* 10(10). Available at: http://www.invs.sante.fr/en.

Ducrot, P., C. Méjean, C. Julia, E. Kesse-Guyot, M. Touvier, L.K. Fezeu, S. Hercberg, and S. Péneau. 2015(b). "Objective Understanding of Front-of-Package Nutrition Labels among Nutritionally At-Risk Individuals." *Nutrients* 7:7106–7125. Available at: www.mdpi.com/journal/nutrientsArticle.

Egnell, M., P. Ducrot, M. Touvier, B. Allès, S. Hercberg, E. Kesse-Guyot, and C. Julia. 2018. "Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: Comparisons with other format labels." *PLoS ONE* 13(8).

Egnell, M., E. Kesse-Guyot, P. Galan, M. Touvier, M. Rayner, J. Jewell, J. Breda, S. Hercberg, and C. Julia. 2018. "Impact of front-of-pack nutrition labels on portion size selection: An experimental study in a French cohort." *Nutrients* 10(9):1–13.

Fialon, M., M. Egnell, Z. Talati, P. Galan, L. Dréano-Trécant, M. Touvier, S. Pettigrew, S. Hercberg, and C. Julia. 2020. "Effectiveness of different front-of-pack nutrition labels among italian consumers: Results from an online randomized controlled trial." *Nutrients* 12(8):1–13.

Graham, D.J., R.G. Lucas-Thompson, M.P. Mueller, M. Jaeb, and L. Harnack. 2017. "Impact of explained v. unexplained front-of-package nutrition labels on parent and child food choices: A randomized trial." *Public Health Nutrition* 20(5):774–785.

Grunert, K.G., L. Fernández-Celemín, J.M. Wills, S.S.G. Bonsmann, and L. Nureeva. 2010. "Use and understanding of nutrition information on food labels in six European countries." *Journal of Public Health* 18(3):261–277.

Hawkes, C., and B.M. Popkin. 2015. "Can the sustainable development goals reduce the burden of nutrition-related non-communicable diseases without truly addressing major food system reforms?" *BMC Medicine* 13(1):1–3. Available at: http://www.wcrf.org/policy_public_affairs/nourishing_framework/index.php] [Accessed June 17, 2021].

Hensher, D.A., J.M. Rose, and W.H. Greene. 2005. *Applied Choice Analysis: A Primer*. Cambridge, UK: Cambridge University Press. Available at: https://books.google.it/books?hl=it&lr=&id=8yZrtCCABAgC&oi=fnd&pg=PR13&dq=Appl

ied+choice+analysis:+a+primer.+&ots=RGJL3Ylbsa&sig=mIcMfhqXmmSo6sr92HtT60klYXE&redir_esc=y#v=onepage&q=Applied choice analysis%3A a primer.&f=false [Accessed June 23, 2021].

Herrera, C.F., and C.F. Blanco. 2011. "Consequences of consumer trust in PDO food products: The role of familiarity." *Journal of Product and Brand Management* 20(4):282–296.

Hole, A.R. 2007. "Fitting mixed logit models by using maximum simulated likelihood." *Stata Journal* 7(3):388–401.

ISMEA. 2019. *Rapporto 2019 Ismea-Qualivita sulle produzioni agroalimentari e vitivinicole italiane DOP, IGP e STG*.

Julia, C., O. Blanchet, C. Méjean, S. Péneau, P. Ducrot, B. Allès, L.K. Fezeu, M. Touvier, E. Kesse-Guyot, E. Singler, and S. Hercberg. 2016. "Impact of the front-of-pack 5-colour nutrition label (5-CNL) on the nutritional quality of purchases: An experimental study." *International Journal of Behavioral Nutrition and Physical Activity* 13(1):1–9. Available at: https://ijbnpa.biomedcentral.com/articles/10.1186/s12966-016-0416-4 [Accessed June 17, 2021].

Julia, C., S. Péneau, C. Buscail, R. Gonzalez, M. Touvier, S. Hercberg, and E. Kesse-Guyot. 2017. "Perception of different formats of front-of-pack nutrition labels according to sociodemographic, lifestyle and dietary factors in a French population: Cross-sectional study among the NutriNet-Santé cohort participants." *BMJ Open* 7(6). Available at: http://bmjopen.bmj.com/.

Kelly, B., C. Hughes, K. Chapman, J.C.Y. Louie, H. Dixon, J. Crawford, L. King, M. Daube, and T. Slevin. 2009. "Consumer testing of the acceptability and effectiveness of front-of-pack food labelling systems for the Australian grocery market." *Health Promotion International* 24(2):120–129. Available at: https://academic.oup.com/heapro/article/24/2/120/571126 [Accessed June 21, 2021].

Lancaster, K.J. 1966. "A New Approach to Consumer Theory." *Current* 74(2):132–157.

McFadden, D. 1973. "Conditional logit analysis of qualittive choice behavior." In P. Zarembka, ed. *Frontiers in Econometrics*. New York: Academic Press New York, pp. 105–142.

Medina-Molina, C., and B. Pérez-González. 2021. "Nutritional labelling and purchase intention interaction of interpretative food labels with consumers' beliefs and decisions." *British Food Journal* 123(2):754–770.

Mora-García, C.A., L.F. Tobar, and J.C. Young. 2019. "The effect of randomly providing nutri-score information on actual purchases in Colombia." *Nutrients* 11(3). Available at:

https://pubmed.ncbi.nlm.nih.gov/30813605/ [Accessed July 2, 2021].

Nagle, M.G., and T.D. Osorio. 1993. “The tuning of human photopigments may minimize red-green chromatic signals in natural conditions.” *Proceedings of the Royal Society B: Biological Sciences* 252(1335):209–213. Available at: https://royalsocietypublishing.org/ [Accessed June 21, 2021].

Neal, B., M. Crino, E. Dunford, A. Gao, R. Greenland, N. Li, J. Ngai, C. Ni Mhurchu, S. Pettigrew, G. Sacks, J. Webster, and J.H. Y Wu. 2017. “Effects of Different Types of Front-of-Pack Labelling Information on the Healthiness of Food Purchases-A Randomised Controlled Trial.” *Nutrients* 9(12). Available at: www.mdpi.com/journal/nutrients.

Ng, M., T. Fleming, M. Robinson, B. Thomson, N. Graetz, C. Margono, E.C. Mullany, S. Biryukov, C. Abbafati, S.F. Abera, J.P. Abraham, N.M.E. Abu-Rmeileh, T. Achoki, F.S. Albuhairan, Z.A. Alemu, R. Alfonso, M.K. Ali, R. Ali, N.A. Guzman, W. Ammar, P. Anwari, A. Banerjee, S. Barquera, S. Basu, D.A. Bennett, Z. Bhutta, J. Blore, N. Cabral, I.C. Nonato, J.C. Chang, R. Chowdhury, K.J. Courville, M.H. Criqui, D.K. Cundiff, K.C. Dabhadkar, L. Dandona, A. Davis, A. Dayama, S.D. Dharmaratne, E.L. Ding, A.M. Durrani, A. Esteghamati, F. Farzadfar, D.F.J. Fay, V.L. Feigin, A. Flaxman, M.H. Forouzanfar, A. Goto, M.A. Green, R. Gupta, N. Hafezi-Nejad, G.J. Hankey, H.C. Harewood, R. Havmoeller, S. Hay, L. Hernandez, A. Husseini, B.T. Idrisov, N. Ikeda, F. Islami, E. Jahangir, S.K. Jassal, S.H. Jee, M. Jeffreys, J.B. Jonas, E.K. Kabagambe, S.E.A.H. Khalifa, A.P. Kengne, Y.S. Khader, Y.H. Khang, D. Kim, R.W. Kimokoti, J.M. Kinge, Y. Kokubo, S. Kosen, G. Kwan, T. Lai, M. Leinsalu, Y. Li, X. Liang, S. Liu, G. Logroscino, P.A. Lotufo, Y. Lu, J. Ma, N.K. Mainoo, G.A. Mensah, T.R. Merriman, A.H. Mokdad, J. Moschandreas, M. Naghavi, A. Naheed, D. Nand, K.M.V. Narayan, E.L. Nelson, M.L. Neuhouser, M.I. Nisar, T. Ohkubo, S.O. Oti, A. Pedroza, D. Prabhakaran, N. Roy, U. Sampson, H. Seo, S.G. Sepanlou, K. Shibuya, R. Shiri, I. Shiue, G.M. Singh, J.A. Singh, V. Skirbekk, N.J.C. Stapelberg, L. Sturua, B.L. Sykes, M. Tobias, B.X. Tran, L. Trasande, H. Toyoshima, S. Van De Vijver, T.J. Vasankari, J.L. Veerman, G. Velasquez-Melendez, V.V. Vlassov, S.E. Vollset, T. Vos, C. Wang, X. Wang, E. Weiderpass, A. Werdecker, J.L. Wright, Y.C. Yang, H. Yatsuya, J. Yoon, S.J. Yoon, Y. Zhao, M. Zhou, S. Zhu, A.D. Lopez, C.J.L. Murray, and E. Gakidou. 2014. “Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013.” *The Lancet* 384(9945):766–781.

Pomeranz, J.L., P. Wilde, D. Mozaffarian, and R. Micha. 2019. “Mandating front-of-package food labels in the U.S. – What are the First Amendment obstacles?” *Food Policy*

86(May):101722. Available at: https://doi.org/10.1016/j.foodpol.2019.05.005.

Revelt, D., and K. Train. 1998. “Mixed logit with repeated choices: Households’ choices of appliance efficiency level.” *Review of Economics and Statistics* 80(4):647–657. Available at: http://direct.mit.edu/rest/article-pdf/80/4/647/1612495/003465398557735.pdf [Accessed June 24, 2021].

Sanjari, S.S., Jahn, S., and Boztug, Y. 2017. “Dual-process theory and consumer response to front-of-package nutrition label formats.” *Nutrition reviews*, 75(11):871-882.

Santos, O., V. Alarcão, R. Feteira-Santos, J. Fernandes, A. Virgolino, C. Sena, C.P. Vieira, M.J. Gregório, P. Nogueira, P. Graça, and A. Costa. 2020. “Impact of different front-of-pack nutrition labels on online food choices.” *Appetite* 154(August).

Schneider, G., and A.P. Ghosh. 2020. “Should We Trust Front-of-Package Labels? How Food and Brand Categorization Influence Healthiness Perception and Preference.” *Journal of the Association for Consumer Research* 5(2):149–161. Available at: https://www.journals.uchicago.edu/doi/abs/10.1086/707929 [Accessed June 29, 2021].

Storcksdieck Gennat Bonsmann, S., G. Marandola, E. Ciriolo, R. Van Bavel, and J. Wollgast. 2020. *Front-of-pack nutrition labelling schemes: a comprehensive review* Publications Office of the European Union, ed. Luxembourg,: Publications Office of the European Union. Available at: https://www.researchgate.net/publication/341701740_Front-of-pack_nutrition_labelling_schemes_a_comprehensive_review.

Talati, Z., M. Egnell, S. Hercberg, C. Julia, and S. Pettigrew. 2019. “Consumers’ perceptions of five front-of-package nutrition labels: An experimental study across 12 countries.” *Nutrients* 11(8). Available at: http://www.anzctr.org.au/ACTRN12618001221246.aspx.

Talati, Z., R. Norman, S. Pettigrew, B. Neal, B. Kelly, H. Dixon, K. Ball, C. Miller, and T. Shilton. 2017. “The impact of interpretive and reductive front-of-pack labels on food choice and willingness to pay.” *International Journal of Behavioral Nutrition and Physical Activity* 14(1):1–10. Available at: https://ijbnpa.biomedcentral.com/articles/10.1186/s12966-017-0628-2 [Accessed June 21, 2021].

Temple, N.J. 2020. “Front-of-package food labels: A narrative review.” *Appetite* 144(October 2019):104485. Available at: https://doi.org/10.1016/j.appet.2019.104485 [Accessed November 17, 2020].

Thorndike, E.L. 1920. “A Constant Error in Psychological Ratings.” *Journal of applied psychology* 4(1):25–29. Available at: https://ci.nii.ac.jp/naid/30013652235/ [Accessed September 9, 2021].

Traets, F., D.G. Sanchez, and M. Vandebroek. 2019. “Generating Optimal Designs for Discrete Choice Experiments in R: The idefix Package.” *Journal of Statistical Software* VV(II).

Train, K.E. 2009. *Discrete choice methods with simulation* 2nd edi. United Kingdom: Cambridge University Press.

Ubilava, D., and K. Foster. 2009. “Quality certification vs. product traceability: Consumer preferences for informational attributes of pork in Georgia.” *Food Policy* 34(3):305–310. Available at: http://dx.doi.org/10.1016/j.foodpol.2009.02.002.

Velasco Vizcaíno, F., and A. Velasco. 2019. “The battle between brands and nutritional labels: How brand familiarity decreases consumers’ alertness toward traffic light nutritional labels.” *Journal of Business Research* 101:637–650.

Vyth, E.L., I.H. Steenhuis, J.A. Vlot, A. Wulp, M.G. Hogenes, D.H. Looije, J. Brug, and J.C. Seidell. 2010. “Actual use of a front-of-pack nutrition logo in the supermarket: consumers’ motives in food choice.” *Public Health Nutrition* (13):1882–1889. Available at: https://www.cambridge.org/core.

WHO. 2020. “World health statistics 2020: monitoring health for the SDGs, sustainable development goals.”

Chapter 5

Nutri-Score: checkmate to Geographical Indications? Evidence from an experimental auction in Italy

Abstract

The EU Farm to Fork strategy (F2F) promotes the compulsory adoption of a nutritional front of pack label to improve the diets of the citizens, supporting healthier food choices, and the Nutri-Score (NS) is, among others, the most favored candidate. Although this labeling system is widely supported within the EU, being effective in guiding consumer choices towards healthier products, oppositions on the political and producer levels are raised against the NS, due to the possible and negative economic impact it could have on specific food sector, and, especially, on Geographical Indications (GIs). Recent literature has stressed the need to investigate this aspect in more detail, highlighted the lack of studies in the literature. This contributes in filling this gap by analyzing consumers' willingness to pay for GI products labeled with different grades of the Nutri-Score. An incentivized non-hypothetical experimental auction was conducted on 200 Italian consumers. Different products representing different levels of NS were used in the experiment, both conventional and GIs. Specifically, a conventional pasta and the Pasta di Gragnano PGI (NS=A), a conventional piadina and the Piadina Romagnola PGI (NS=C), and a conventional hard cheese and the Parmigiano Reggiano PDO were considered in the survey. Results suggest that the NS generates premiums and penalties in consumers' willingness to pay respectively for A and D scores, coherently with the expectations. Misunderstanding of the labels significantly decrease the efficacy of this health tool, stressing the need to have effective communication strategies within the EU to reach the F2F goals. GIs are generally penalized by the NS adoption, especially considering the more loyal GI' consumers' segment. However, the most well-known GIs, as Parmigiano Reggiano PDO, do not

suffer from the negative effect of the NS, as the positive value associated to the GI offset the negative effect of the NS.

Keywords: Farm to Fork; traditional foods; PDO; PGI; European Union; Parmigiano Reggiano; Pasta di Gragnano PGI; Piadina Romagnaola PGI

5.1. Introduction

Overweight and obesity are the main nutritional issues at the global level, affecting almost 40% of the population (World Health Organization, 2021), and burdening society also at the economic level, with 2-7% of all healthcare spending addressed to prevent and to treat this condition (Dobbs & Manyika, 2015). Yet, an increased Body Mass Index (BMI) is a major risk factor also for several other non-communicable diseases (NCDs), such as cardiovascular diseases, musculoskeletal disorders, and cancer, which account for 41 million deaths annually, namely 71% of global deaths (Habib & Saha, 2010; World Health Organization, 2021). Literature shows that poor diet quality is a triggering factor of this global health condition (Hall et al., 2019; Nseir et al., 2010; World Health Organization, 2021), pushing public health authorities to develop strategies and to introduce policies focused on nutrition, to cope with this issue.

At the European level, the European Commission, within the Farm to Fork (F2F) strategy, sought to introduce by 2022 a mandatory and harmonized Front-Of-Pack (FOP) nutritional labelling on prepacked foods, to face the obesity crisis by encouraging healthier diets. Used as a support to the back-of-pack (BOP) nutrition tables (European Commission, 2020a), the FOP label should provide consumers with easy-to-understand information about the nutritional profile of foods, stimulating at the same time food reformulation towards healthier foods. However, the proposal imposing standardized EU food health labels is being delayed to the next legislation by political battles and disputes between governments.

Indeed, different FOP labels are currently adopted at the EU level (Storcksdieck Gennat Bonsmann et al., 2020), such as the Green Keyhole in Scandinavian Countries, the NutrInform battery in Italy, the Traffic Light labels in Spain and Portugal, or the Nutri-Score (NS), adopted for the first time in France in 2017, and now widely spread in Europe. Most of them are

Nutrient-specific labels (such as the Traffic Light Label or the NutrInform battery), highlighting, in most cases, the content of energy, saturated fat, sugar, sodium, and salt per serving. Despite being particularly useful to highlight the harmful nutrients consumed in excess, these labels seem not to be the best solution when differentiating healthier and less healthy foods, within a spectrum of dietary options (Temple, 2020). Indeed, summary labels, as NS, are considered more efficient than other FOP labels to classify products according to their nutritional quality (Ducrot et al., 2015a), as they use an algorithm to translate the components of the food into a single value that denotes how healthy or unhealthy it is (Temple, 2020).

Different scholars consider the NS as the best nutrition FOP labels to be adopted at mandatory level, being the most efficient to classify products according to their nutritional profile when tested in real-life (Ducrot et al., 2015a), hypothetical studies (Ducrot et al., 2015b; Fuchs et al., 2022; Julia, Blanchet, et al., 2016; Shin et al., 2023), and if used along with other quality labels (De Bauw et al., 2021a, 2022). Nonetheless, its adoption at the Community level seems to be undermined by some controversies, arisen especially in the Mediterranean countries (M Fialon et al., 2021; Stiletto & Trestini, 2022), with Italy and Spain being the major objectors (Stiletto et al., 2023).

The NS label, being a five-step color-graded nutrition label, highlights the nutritional value of 100 g of the product using jointly a chromatic and alphabetical scale, considering the content of nutrients and foods that should be consumed more frequently, namely fruits and vegetables, fiber, proteins, nuts, rapeseed and olive oils, and the content of nutrients and foods that should be limited in consumption, such as energy, saturated fatty acids, sugars, and salt. Looking at the NS grades of different products, consumers should be able to compare products and choose the healthiest one within a given category (Julia & Hercberg, 2017b). However, some food categories are entirely negatively evaluated by this nutrient profiling system, such as products of animal origin, due to their high content in calories and saturated fats (Stiletto & Trestini, 2022), thus preventing consumers from distinguishing the most nutritionally valid product among those offered. Although this may seem in contrast with the initial objectives set by the NS, this classification system seems to be in line with the Mediterranean Diet's principles, which consider products of animal origin foods to be consumed in moderation (Vlassopoulos et al., 2022).

Recent literature pointed out that products negatively evaluated by the NS generally suffered by market dynamics, as consumers are willing to pay less for them (Stiletto & Trestini, 2022) and, therefore, prices and volumes of these products could drop (Chapter 5). Although

this decrease in prices is a natural consequence of the laws of the market (and a desirable effect of the Green Deal and F2F strategy), this reduction in the consumers' willingness to pay (WTP) could represents a hurdle for Geographical Indication (GI) products (Chantal et al., 2022), which are generally promoted and protected by the EU for their superior quality (Reg. 1151/2011). These certification system allows producers to market their products better, with a value premium rate stood at 1.5 for agricultural products and 2.85 for wines (European Commission, 2020b). Besides, GIs represent a positive and effective tool for booster local economic development (Crescenzi et al., 2022), one of the pillar of the F2F strategy, which aims reaching a robust and resilient food system, and allow to guarantee fair incomes for producers.

However, most of GIs, being of animal origin, will receive a negative NS grade. Nevertheless, these product have a market share around 52%, with Italy being the lading country in terms of GIs registered (Török & Moir, 2018). In Italy, 9 out the first 10 GIs by production value are of animal origin, accounting for 85% of GI production value and 40% of the national export of products of animal origin (ISMEA, 2021). As a result, the effect of the NS adoption on GIs seems to be a double trouble, highlighting inconsistencies not only between policies (F2F and GI policy), but also within the same strategy, with the F2F promoting the GIs on the one hand and damaging most of these products on the other ones.

Against this background, Italian government stand against the NS adoption, embracing the aversions of the main Agro-Food companies (Julia & Hercberg, 2016; Stiletto et al., 2023). These complaints, together with the debates raised in other countries – such as in Spain for the supposed inconsistencies in the classification of traditional olive oil (M Fialon et al., 2021) – have forced the European Commission to postponed the presentation of the proposal of a single FOPL to the next legislature (i.e., to the 2024). Despite the relevance of this topic, only few scientific works have been published on this issue, trying to evaluate the impact on consumer preferences of the NS label applied on quality products (M Fialon et al., 2021; Stiletto & Trestini, 2022), especially on non-hypothetical market (Chapter 5), or shedding some lights on the NS adoption debate in Europe (Stiletto et al., 2023). Considering this, the present study aims to assess consumers' preferences for NS labelled products in Italy, using both real products and an incentive-compatible mechanism, being the best approximation of the true preferences corresponding to real payments in groceries (Chang et al., 2009). Specifically, the empirical analysis aims to address the following research questions:

What is the effect of the NS label on consumers' willingness to pay? (RQ1)

Which are the determinants that affect consumers' WTP variation for products labelled with NS? (RQ2) The paper is organized as follows: data collection and model specification are provided in the next section. Section 3 collects results, while discussions are reported in section 4. Some conclusions are drawn in section 5. Finally, in the last section, the policy implications of the present study are reported.

5.2. Materials and Methods

5.2.1. Experimental procedure

To elicit consumers' WTP for food products labelled with the NS, a non-hypothetical experimental auction mechanism has been applied (Lusk & Shogren, 2007). Specifically, a Becker–DeGroot–Marschak (BDM) (Becker et al., 1964) experimental auction (EA) has been employed in this study, being, along with the Vickrey auction (Vickrey, 1961), one of the most two widely used demand-revealing mechanisms in experimental economics (Noussair et al., 2004). In BDM auctions, participants simultaneously submit their offer price to purchase a given good. Afterwards, a sale price is randomly drawn from a distribution of possible sale prices for that specific good. Any participant who submits a bid greater than the extracted sale price receives one unit of the extracted good (to avoid welfare effect) and pays an amount equal to the sale price extracted. The welfare effect, undergoing to the law of diminishing marginal utility, asserts that every additional unit of a good lowers the extra utility gained by consuming the product. Therefore, to avoid biases in WTP estimations, participants were aware that only one product and one round are drawn at the end of the experiment (Shogren et al., 1994). Besides, bidding against a random price, participants are not really competing each other's, thus reducing undesirable effects as affiliation, collusion, or competition (Lusk & Shogren, 2007).

The experiment was performed during May 2023 in a controlled environment, managed by a recruitment agency and designated for survey administration. A total of 200 Italian adult consumers, representative of the Italian population in terms of age and gender, were recruited by the agency. The only mandatory requirement needed to participate in the experiment was to consume the products under investigation (i.e., pasta, piadina, and seasoned cheese, as better described in the following section) to avoid biases in the estimation. In the data analysis

process, 12 consumers were dropped from the sample, being considered outliers (as their responses are significantly higher than the medium values, presumably for typing errors in the responses). Participants in the experiment are split in 20 different sessions, within 6 different working days, with 10 consumers each. The complete experimental procedure comprised seven phases (as described in Figure 5.1), hereafter described more in detail, was approved by the University Research Ethical Committee.

Figure 5.1. Overview of the experiment

First of all, participants are welcomed in the room and asked to sign the individual consent form (1), which is mandatory to participate in the experiment. This document outlines the objectives of the research, defines the experiment structure, and highlights the participant's rights. Participants received a monetary endowment of 20€ to participate in the experiment (2), which should be considered as a reimbursement of expenses for the time spent for the research. Then, before filling the survey, participants were instructed about the rules of the experiment. Communication between respondents was minimized to avoid possible interactions altering individual decisions. Afterwards, respondents filled a general survey on their dietary habits, which also collected socio-demographics information (3). Then, the BDM auction was fully explained (4), and a training session (5) with two versions of protein bars, chocolate snacks and candies were performed to help respondents to familiarized with the EA mechanisms. In this phase, consumers were encouraged to ask questions for clarification, if needed. Completed the test session and dispelled any doubts of the participants, the experimental auction was conducted in two rounds: the first is the so-called "control" round (without information treatment), while the second is the information treatment round (see section 5.2.3 for more details) (6). In the final step of the experiment, one round, one product, and one price are drawn. Then, all the participants submitting a bid higher than the extracted sale price for the extracted product "buy" one unit of the product at the extracted sale price (7).

5.2.2. Products

Three categories of foods (namely, pasta, piadina, and seasoned cheese), both bearing GI and their counterparts without GI (i.e, the conventional), were evaluated in the experiment (Figure 2). These food categories were chosen based on Italian consumers' familiarity with these products and for the NS grade of the category. Indeed, pasta is one of the main sources of carbohydrates for Italians (Altamore et al., 2020), as well as one of the cornerstone foods of the Mediterranean diet (Nutri-Score = A). The GI pasta considered in the experiment, namely the "Pasta di Gragnano PGI", with 300 million € of consumption value currently, is a very renowned product in Italy, being the ninth largest GI product by value in Italy (Qualivita, 2022). Also, 48.8% of the consumers in the experiment are found to known this good. The second product considered in the experiment, namely the piadina, is a simple baked product made of wheat flour, water, fat (lard or olive oil) and salt. According to Nielsen data, its sales in Italian large-scale retail trade exceeded 190 million euros in 2021, with a growth of +12.4 % in value and 13.8 % in volume compared to 2020 (Benfatto, 2021). From a nutritional point of view, it represents a good alternative to bread, with a Nutri-Score grade equal to C (if made with olive oil). Considering the GI, the Piadina Romagnola PGI is gaining more and more interest among consumers, with an increase of 24.5% both in quantity and in value compared to 2018 (ISMEA, 2019), and with 73.9% of the respondents in the survey knowning this GI. When considering the third product in the analysis, namely hard cheese, it is worth to noticed that Italy is one of the leading producers of cheese worldwide (Koppel & Chambers, 2012), with a per-capita consumption equal to 23kg/year (Ballarini, 2022) and 88.46% of consumers in the experiment knowing the product. Parmigiano Reggiano PDO is the second PDO product in Italy for production value, and is highly appreciated for its quality (Hillmann & Hofmann, 2016). Nonetheless, due to its high fatty acid and calories content per 100 grams, it is negatively rated by the Nutri-Score profiling system (NS = D).

5.2.3. Study design and WTP elicitation procedure

The EA was based on a within-subject design. Therefore, all respondents participated in both rounds. In the first-round participants are provided with six different products (Figure 5.2), differing for category and for the presence of GI, in randomized order. Specifically, there

were 2 different type of pasta, piadina, and hard cheese: the conventional one and the GI one, being the only attribute differing for each type of product. After the first round, participants are asked to evaluate again the six products, but they were provided with additional information about their nutritional scores, as Nutri-Score was displayed on the proposed products in round 2. General information about the NS label, retrieved from the official website of this label (Santé Publique France, 2022), were provided to consumers before round 2, to avoid biases in the estimation due to different consumers' backgrounds.

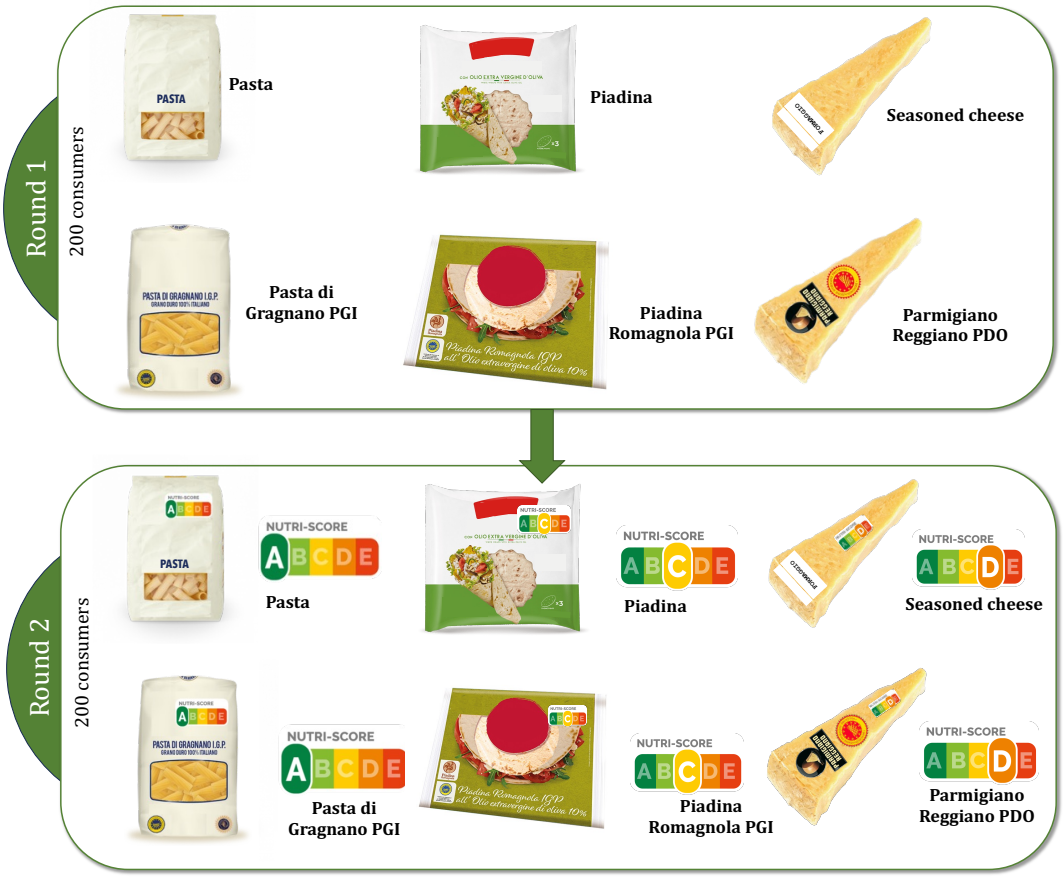

Figure 5.2. Experimental design and product specification

Respondents were asked to state their WTP for the six proposed products in two different rounds, submitting 12 bids at the end of the experiment. To avoid affiliation effect (Lusk & Shogren, 2007), price feedback was not provided between rounds, as reported also by Lombardi et al. (2019).

5.2.4. Psychographic measure and econometric analysis of the WTP

5.2.4.1. Psychographic measure

To answer the second research question, thus highlighting the main factors affecting the variation in consumers' WTP due to the NS information (provided in round 2), participants' attitudes and beliefs towards food consumption and dietary behaviors were collected. Specifically, to investigate the major drivers of respondents' food consumption, the renowned Food Choice Questionnaire (Steptoe et al., 1995) was used in the single-item version proposed by Onwezen et al. (2019). Besides, to catch consumers' attitude towards a healthy diet, the perceptions about healthy eating 5-points Likert scale, coined by Wongprawmas et al. (2021), was used. As reported in Table 5.1, both the scales have an internal consistence exceeding the reliable threshold value, as Cronbach's α values were 0.832 for the FCQ and 0.705 in the Healthy eating scale.

Table 5.1. Psychographic measurements (FCQ and Healthy Eating Scale)

Food Choice Questionnaire (FCQ)	Cronbach's α: 0.832	
It is important to me that the food I eat on a typical day is…	**Mean**	**Std. Dev**
Healthy	6.25	1.28
Is a way of monitoring my mood (e.g., a good feeling or coping with stress)	5.05	1.65
Is convenient (in buying and preparing)	5.39	1.62
Provides me with pleasurable sensations (e.g., texture, appearance, smell, etc.)	6.56	1.27
Is natural	5.58	1.54
Is affordable	4.71	1.53
Help me control my weight	5.11	1.73
Is familiar	4.66	1.70
Is environmentally firendly	5.53	1.54
Is animal firendly	5.19	1.60
Is fairly traded	4.82	1.62
Healthy Eating Scale (HES)	Cronbach's α: 0.705	
	Mean	**Std. Dev**
A healthy diet should be balanced, varied, and complete	6.67	0.89
Fruit and vegetables are very important to healthy eating	6.71	0.79
We can eat everything, as long as in small quantities	5.89	1.49
I believe that organically produced food is healthier	4.54	1.58
A healthy diet is based on calorie count	3.91	1.75
I believe that tradition is very important to a healthy diet	4.01	1.82
I believe that a healthy diet is not cheap	3.98	1.97
We should never consume sugary products	4.41	2.02
We should never consume fat products	4.30	1.89
In my opinion, it is strange that some people have cravings for sweets	3.80	2.05

Then, the eating habits of consumers were investigated for the three product categories considered in the survey, along with their perceptions and understanding of the NS label after

the information treatment given in round 2. Specifically, consumers were asked to evaluate the products under investigation according to their nutritional value, using the NS as a discriminant factor (Figure 5.3). A list of possible interpretations of different NS values (reported in Figure 3) found in literature were provided to respondents to evaluate the six products. Specifically, a bunch of studies described the products with a Nutri-Score equal to "A" or "B" as "healthy" or "healthier" foods and those with Nutri-Score equal to "D" or "E" as "unhealthy" (see for instance: Dréano-Trécant et al., 2020; Katsouri et al., 2021; Romero Ferreiro et al., 2021; Ter Borg et al., 2021). Besides, others identified the first products as foods with "high nutritional value" or "nutritionally valid products" and the seconds as "nutritionally invalid products" or goods with "poor nutritional quality" (Blasco & Jiménez-Morales, 2021; Forner et al., 2021; Hafner & Pravst, 2021; Jiménez-Morales & Montaña Blasco, 2021), while only few paper used the terms "to be avoid in consumption" when products have low scores, as Blasco & Jiménez-Morales (2021) or Valenzuela et al. (2022).

As reported in Figure 5.3, consumers' perception of the nutritional value of foods expressed by the Nutri-Score label is not homogeneous among subjects. Despite the guidelines of the French label (Santé Publique France, 2022) stating that a product with a "negative" Nutri-Score (i.e., NS = D; NS = E) is to be considered a product to be "limited in consumption", almost one fifth of the respondents interpreted Parmigiano Reggiano, labelled with a negative Nutri-Score (NS = D), as a nutritionally valid product (16.5%) or a healthy one (2.5%), while 7% considered it as a nutritionally invalid product, 2.0% as an unhealthy one, and 2.0% as a products not to be consumed. These figures partially differ when considering the conventional cheese, as more consumers (11.5%) considered the seasoned cheese a nutritionally invalid product or a food not to be consumed (7.0%), while fewer consumers recognized it as a healthy (1.0%) or nutritionally valid product (7.0%). When considering products with a "positive" NS level, it emerged that 11.0% of consumers believe that Pasta di Gragnano PGI (NS = A) is a food to be limited in consumption, while almost 50.0% of respondents considered it as a healthy product (18.0%) or a nutritionally valid one (38.0%), even if the official interpretation (Santé Publique France, 2022) should be "a product to be consumed frequently", as correctly interpreted by 33.0% of consumers. The same goes for the conventional pasta interpretation when labelled with a positive NS (NS = A), as almost 60% of consumers considered it as a nutritionally valid product (40.5%) or a healthy one (17.5%), while only 28.5% as a product to be consumed frequently. When considering the "medium score" products, as the conventional

piadina and the Piadina Romagnola PGI, both with a NS equal to C, consumers generally perceived it as a product to be limited in consumption (76.0 %).

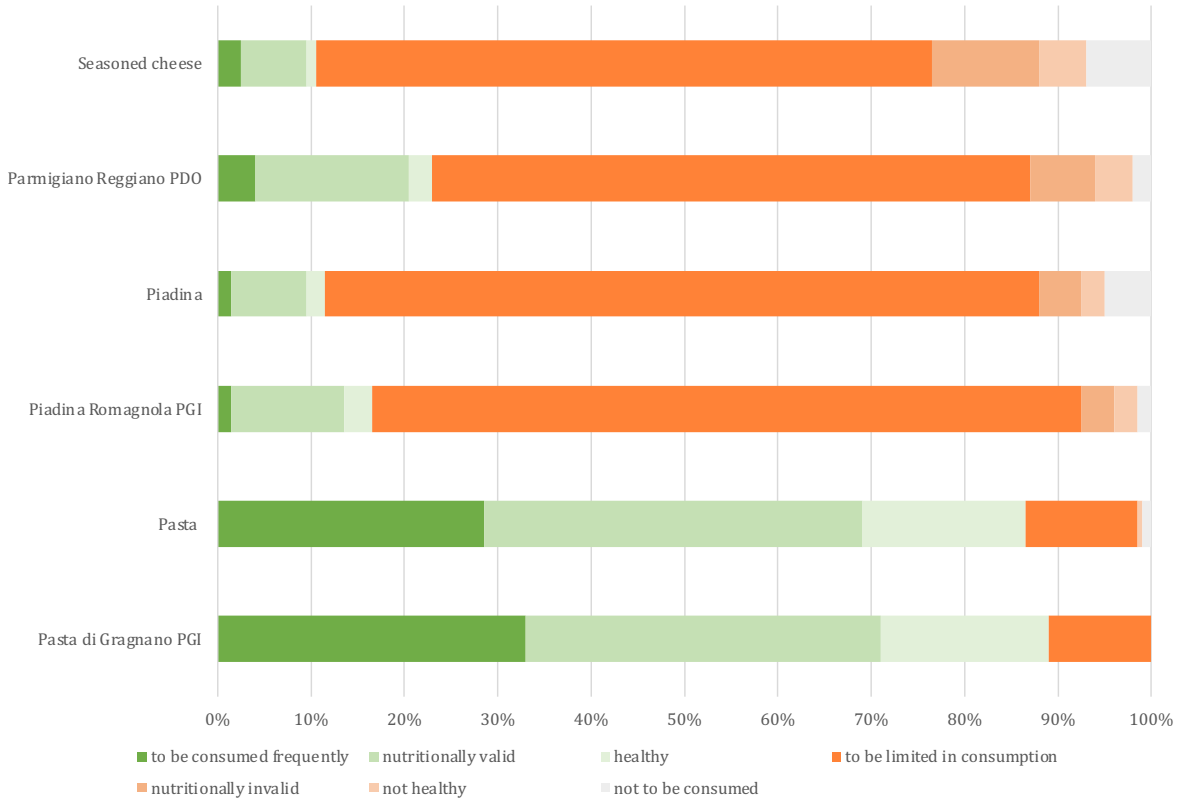

Figure 5.3. Consumers' interpretation (share of respondents in %) of the different products according to their NS levels

Note: Consumers are asked to define the nutritional values of the products according to their NS levels. A list of possible interpretation of the NS grade found in literature was provided.

5.2.4.2. Econometric analysis of the WTP

To answer the two RQs, consumers' willingness to pay measurements was estimated through different models using STATA 17. Specifically, to provide an overview of the effect of the NS label on consumers' preferences (RQ1), an Ordinary Least Squared (OLS) regression of the WTP on products' attributes has been performed. Then, to assess the factors affecting the variation in consumers' WTP due to the NS presence (RQ2), a Seemingly Unrelated Regression (SUR) model has been estimated. More in details, the effect of the t-th NS grades on consumers' willingness to pay of the i-th respondents for the j-th tested products has been estimated to

address RQ1, highlighting differences existing between conventional and GI products, as expressed in equation 1:

$$WTP_{i,j,t} = \beta x_j + \gamma z_t + \varepsilon_{i,j,t} \quad (5.1)$$

where *x* is a vector of variables identifying the products considered in the analysis and *z* is a vector of variables representing NS levels. An OLS estimation has been applied to this model, being robust and unbiased.

Then, to understand the role of psychographic and demographic variables driving consumers' preferences for NS labelled products (RQ2), a SUR model, comprehensive of the following six equation (5.2), has been estimated:

$$\begin{cases} \Delta WTP_{pasta,i} = \beta x'_{pasta} + \gamma z'_{pasta} + \varepsilon_{pasta,i} \\ \Delta WTP_{piadina,i} = \beta x'_{piadina} + \gamma z'_{piadina} + \varepsilon_{piadina,i} \\ \Delta WTP_{cheese,i} = \beta x'_{cheese} + \gamma z'_{cheese} + \varepsilon_{cheese,i} \\ \Delta WTP_{pasta\_PGI\ i} = \beta x'_{pasta\_PGI} + \gamma z'_{pasta\_PGI} + \varepsilon_{pasta\_PGI,i} \\ \Delta WTP_{piadina\_PGI,i} = \beta x'_{piadina\_PGI} + \gamma z'_{piadina\_PGI} + \varepsilon_{piadina\_PGI,i} \\ \Delta \square\square TP_{cheese\_PDO,i} = \beta x'_{cheese\_PDO} + \gamma z'_{cheese\_PDO} + \varepsilon_{cheese\_PDO,i} \end{cases} \quad (5.2)$$

where the dependent variable is represented by the difference expressed by each i-th consumers in WTP between products with and without the NS label (ΔWTP), x is a vector of psychographic measurements and z is a vector of socio-demographic variables. The error terms (ε), is assumed to be independent among individuals and correlated across equations. Descriptive statistics of the variables included in the model are reported in Table 5.2a and Table 5.2b.

Table 5.2a Descriptive statistics of the variables (not product dependent) in model 2

Variable	Description	Mean	Std. Dev
HES	*Healthy Eating Scale*	4.83	± 0.85
Age	*In years*	49.81	± 16.44
Gender	*Male = 1*	0.57	±0.63
Household	*Household size*	2.96	± 1.44
Control (hunger)	*Control variable for the hunger level of respondents*	4.05	± 2.30
Overweight or Obese	*Dummy variables defining overweight and obese people according to the BMI*	0.43	± 0.49
FCQ_weight	*FCQ item: "It is important to me that the food I eat on a typical day…Help me to control my weight"*	5.13	± 1.72
FCQ_familiar	*FCQ item: " It is important to me that the food I eat on a typical day…Is familiar*	4.634	± 1.70
		Freq	**In %**
Family income:			
Less than 2,500€/month	*2500€/month is the average income level for an Italian family, according to ISTAT (Italian National Statistics Institute)*	41	21.80
About 2,500€/month		97	51.59
More than 2,500€/month		45	23.94
Not declared		7	3.83

Table 5.2b Descriptive statistics of the variables (product dependent, i.e., mean and std. dev value depend on the type of product) in model 2

	Pasta di Gragnano PGI		Piadina Romagnola PGI		Parmigiano Reggiano PDO		Pasta (conventional)		Piadina (conventional)		Seasoned cheese (conventional)	
	Mean	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
Frequency of Consumption	3.31	± 1.80	0.63	± 1.03	3.31	± 2.08	3.31	± 1.80	0.63	± 1.03	3.31	± 2.08
Values of the GI	0.38	± 0.45	0.39	± 0.45	1.02	± 1.21	-	-	-	-	-	-
Price _base	1.29	± 0.63	1.95	± 0.98	6.12	±3.77	1.29	± 0.63	1.95	± 0.98	6.12	±3.77
NS wrong Interpretation	0.12	± 0.32	0.17	± 0.38	0.22	± 041	0.134	± 0.34	0.12	± 0.32	0.11	± 0.31
WTP Round1	1.18	± 0.60	1.73	± 0.94	3.20	±1.62	0.799	± 0.48	1.34	± 0.79	2.23	±1.33
WTP Round2	1.35	± 0.64	1.56	± 0.95	2.83	± 1.61	1.04	± 0.58	1.28	± 0.80	1.89	± 1.25

Note: Frequency of Consumption = average frequency of consumption of the good (the value indicates the frequency of consumption for the product type (i.e., pasta, piadina, and cheese) without distinguishing between conventional and GI); Values of the GI = value given to the GI in monetary terms (i.e., ΔWTP: WTP for GI – WTP for conventional products) WTP base = WTP that consumers usually have for the product type (i.e., pasta, piadina, and cheese) without distinguishing between conventional and GI; NS wrong interpretation = dummy variable that reflects an incorrect interpretation of the NS (i.e., considering a product "healthy" or "nutritionally valid" when have a NS = D and vice versa); WTP Round1 = average WTP in Round 1 (no info); WTP Round2 = average WTP in Round 2 (info treatment with NS

5.3. Results

To elicit consumers' preferences towards products labelled with the NS, highlighting differences in its effect between GI and conventional ones, a baseline OLS model has been estimated. Results (reported in Table 5.3) underline that the NS label have a significant role in guiding consumers' preferences, altering respondents WTP based on its levels, while only partially depending on the presence of the Designation of Origin.

Table 5.3 Consumers' WTP estimates

Variables	Coeff.	Std. Err.	P-value
Pasta	0.799	0.081	0.000
Piadina	1.430	0.081	0.000
Seasoned Cheese	2.230	0.081	0.000
Pasta di Gragnano PGI	0.378	0.115	0.001
Piadina Romagnola PGI	0.301	0.115	0.009
Parmigiano Reggiano PDO	1.020	0.115	0.000
NS = A	0.244	0.115	0.033
NS = C	-0.149	0.115	0.194
NS = D	-0.349	0.115	0.002
NS = A*GI	-0.070	0.162	0.666
NS = C*GI	-0.019	0.162	0.905
NS = D*GI	0.349	0.162	0.031
Adj-R^2	**0.696**		

Specifically, the presence of a positive NS (NS = A) increases, on average, consumers' WTP ($\beta_{NS=A}$ = 0.244) for the products labelled with the NS. Indeed, the respondents in the experiment are willing to pay about 24 cent more for a 500g pack of pasta when labelled with the NS (i.e., €1.04 against 0.80€ of the same pack without the NS displayed[14]). The same goes for the PGI pasta labelled with NS, considering that the effect of the NS on GIs (*NS = A*GI*) is not statistically different from the effect on conventional one. Conversely, consumers decrease their WTP for a product with a negative Nutri-Score. Indeed, respondents are willing to pay (-)0.35€ less for the same pack of seasoned cheese when labelled with a Nutri-Score equal to D ($\beta_{NS=D}$ = -0.349). However, this negative effect, due to the presence of a negative NS, is not the same for the PDO seasoned cheese (namely, Parmigiano Reggiano PDO), as the interaction

[14] In this model, coefficients can be interpreted as the average WTP of consumers for different attributes. Starting from the base price (i.e., from the coefficients of Pasta, Piadina, and Seasoned Cheese), the average WTP for the product with specific characteristics (i.e., with NS or GI) should be derived by adding (or diminishing) to the base WTP the coefficient of the specific cue. For example, the average WTP estimated for a conventional pasta labelled with NS=A (€ 1.04) is given by the WTP-base of the pasta (0.80€) added by the estimated WTP for the NS=A (i.e., + 0.24€).

variable between NS and GI ($\beta_{NS=D*GI}$ = +0.349€) has a positive and statistically significant effect for this product, mitigating the average negative effect of the NS ($\beta_{NS=D}$ = -0.349).

On the contrary to what happens for the products on the extremes of the scale for their nutritional values (namely, pasta and seasoned cheese), when considering products with intermediate NS grade, as the piadina (NS=C), results suggest that, on average, the presence of the NS does not significantly alter consumers' WTP. This is coherent with results in Figure 5.4, which shows the WTP distributions for all the products under investigation. Indeed, the distribution of the ΔWTP (Figure 4 c), namely the differences in WTP when the NS labelled is displayed on the pack (round 2) with respect to the baseline condition (no NS displayed, round 1), has a distribution centered on zero for NS=C. Conversely, a shift towards right is detectable for products with NS equal to A (Figure 5.4 a and b) and towards left for the products labelled with negative NS (Figure 5.4 a and b).

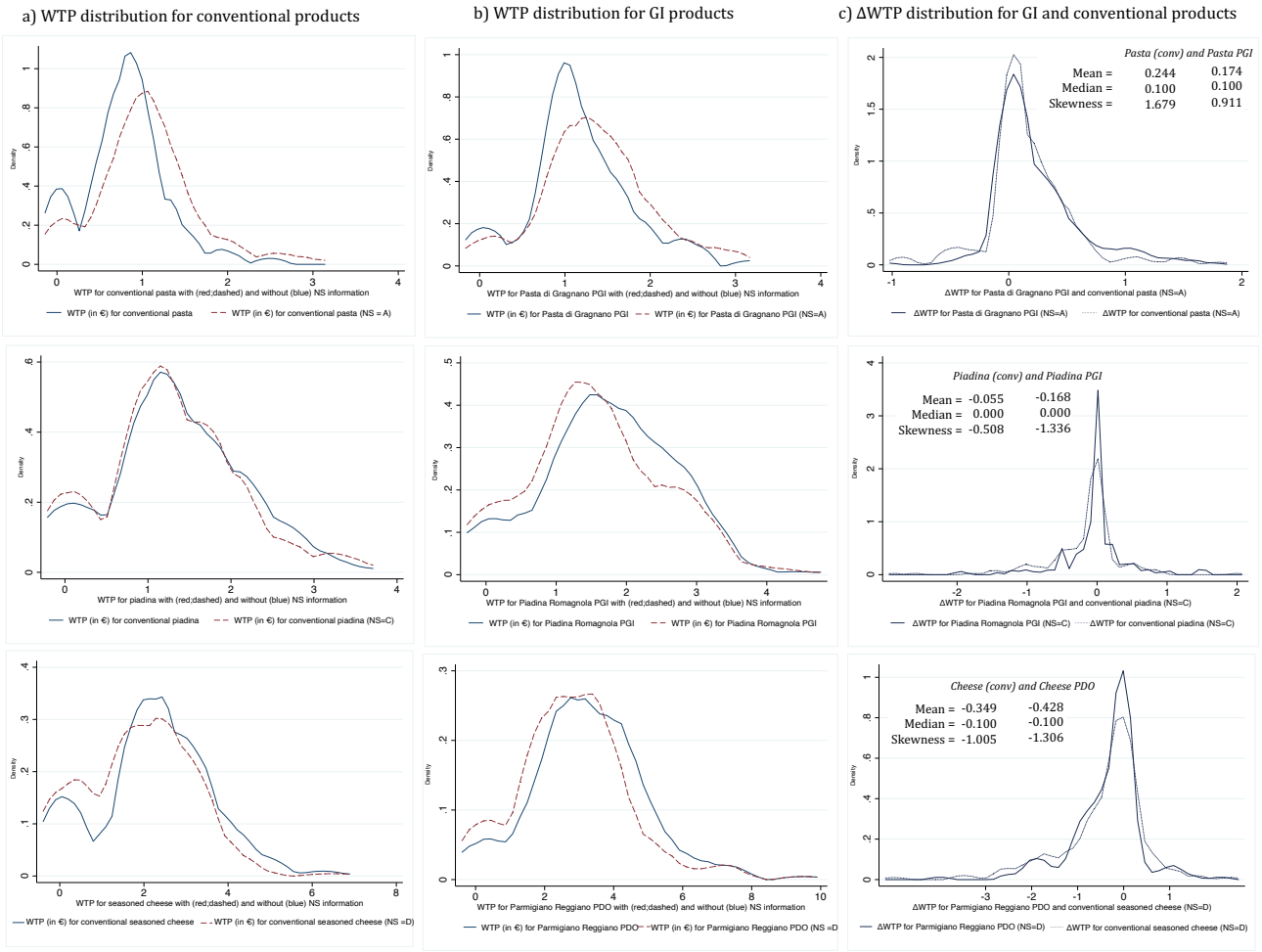

Figure 5.4. Kernel density WTP distribution for conventional products (a), GIs (b), and for ΔWTP (c), which represents the difference in WTP before (round 1) and after (round 2) the NS information treatment

When considering the factors affecting consumers changing in WTP due to the NS presence, results of the SUR model (Table 4) highlight only few common patterns in consumers' preferences. Specifically, a wrong interpretation of the NS label (*NS wrong interpretation*) drastically turns consumers' behaviors, decreasing their WTP for the products that should be consumed frequently (β_{Pasta_PGI} = -0.118; β_{Pasta} = -0.189) and increasing it for those to be reduced in consumption (β_{cheese_PDO} = 0.508; β_{cheese} = 0.386), thus reducing the effectiveness of the NS tool in guiding consumers' towards healthier choices. Yet, consumers' preferences and loyalty for GIs have an important effect on respondents' WTP. Indeed, the more consumers are involved with the GIs (*Values of the GI*), being generally willing to pay more for GI products compared to the corresponding conventional version, the less they are willing to pay for GIs when the NS is applied on these products (β_{pasta_PGI} = -0.262; $\beta_{piadina\_PGI}$ = -0.398). On the contrary, they attached greater values to the conventional one after the information treatment, being willing to pay more for these products (β_{pasta} = 0.349; $\beta_{piadina}$= 0.206; β_{cheese} = 0.148). When it comes to the psychographic measurements, results suggest that consumers' interest in a healthy lifestyle affect consumers' choices only for specific products. The more consumers pay attention to choose foods that allow them to control their weight (*FCQ_weight*), the more the difference in WTP (ΔWTP) for products with positive NS increases (β_{Pasta_PGI} = 0.052; β_{Pasta} = 0.049). It follows that, for these consumers, the presence of the NS (NS=A) has a booster effect in directing them towards healthier foods. On the contrary, the presence of a negative NS (NS=D) decreases consumers' WTP for the products considered to be limited in consumption, as in the case of the Parmigiano Reggiano PDO (β_{cheese_PDO}= -0.069). Besides, consumers who attach importance to follow a healthy and balanced diet (*HES*) are less likely to buy foods with negative NS (β_{cheese}= -0.144; β_{cheese_PDO}=-0.151), reducing their WTP for these products, in line with the NS policy.

Interestingly, for consumers seeking homelike feelings in their purchases (*FCQ_familiar*), seeing a positive NS on the pack increases their willingness to pay (β_{pasta}= 0.037) for the product. Considering the demographic variables, it emerged that income level (*Income*) affects consumers' preferences especially for non-everyday products, such as the piadina, both the conventional ($\beta_{piadina}$= 0.062) and the PGI one ($\beta_{piadina\_PGI}$= 0.104), and the PGI pasta (β_{pasta_PGI}= 0.055), while the age (*Age*) seems to have a significant and negative effect only for the PGI pasta (β_{pasta_PGI}= -0.004). To avoid biases in the estimation, the price that consumers usually pay for the products under investigation has been included in the model

(*price_base*). In fact, it emerges that the differences in terms of WTP (ΔWTP) is influenced by the price base for both PGI pasta (β_{Pasta_PGI} = 0.111) and piadina, in both the conventional ($\beta_{piadina}$ = -0.100)and PGI (β_{iadina_PGI} = -0.065) versions. For the same reason, a control variable detecting differences in the hunger level (Control hunger) of respondents has been included in the model, although it does not significantly affect ΔWTP.

Table 5.4 Seemingly Unrelated Regressions coefficients of the ΔWTP estimation

ΔWTP	**Pasta di Gragnano PGI**		**Piadina Romagnola PGI**		**Parmigiano Reggiano PDO**		**Pasta (conventional)**		**Piadina (conventional)**		**Seasoned cheese (conventional)**	
	(pasta_PGI)		*(piadina_PGI)*		*(cheese_PDO)*		*(pasta)*		*(piadina)*		*(cheese)*	
HES	-0.039		-0.057		-0.151	*	-0.035		-0.052		-0.144	**
	(-0.034)		(0.049)		(0.088)		(0.037)		(0.043)		(0.069)	
Gender (male =1)	-0.592		-0.045		-0.002		-0.047		0.059		-0.005	
	(0.451)		(0.619)		(0.004)		(0.002)		(0.547)		(0.887)	
Age	-0.004	**	-0.002		-0.001		0.000		-0.000		0.003	
	(-0.002)		(0.003)		(0.005)		0.002		(0.002)		(0.004)	
Household	-0.036	*	0.002		-0.005		-0.023		0.025		-0.009	
	(0.018)		(0.0269		(0.048)		(0.020)		(0.023)		(0.037)	
Control (hunger)	-0.009		0.016		0.006		0.002		0.013		0.010	
	(0.011)		(0.016)		(0.029)		(0.012		(0.014)		(0.022	
Income	0.055	*	0.104	**	0.072		0.026		0.062	**	0.090	
	(0.028)		(0.040)		(0.073)		(0.031)		(0.035)		(0.057)	
Overweight or Obese	0.052		0.021		0.100		-0.023		0.040		0.131	
	(0.050)		(0.071)		(0.129)		(0.055)		(0.062)		(0.102)	
Frequency of Consumption	0.019		-0.017		0.042		-0.004		0.025		0.023	
	(0.014)		(0.033)		(0.029)		(0.015)		(0.028)		(0.022)	
Values of the GI	-0.262	***	-0.398	***	-0.049		0.349	***	0.206	***	0.148	***
	(0.054)		(0.077)		(0.049)		(0.059)		(0.028)		(0.039)	
FCQ_weight	0.052	***	-0.007		-0.069	*	0.049	***	0.001		-0.049	
	(0.016)		(0.023)		(0.041)		(0.018)		(0.020)		(0.032)	
FCQ_familiar	0.024		-0.007		-0.007		0.037	**	0.003		-0.026	
	(0.016)		(0.022)		(0.041)		(0.017)		(0.020)		(0.032)	
Price_base	0.111	***	-0.065	*	-0.007		0.067		-0.100	***	-0.015	
	(0.038)		(0.034)		(0.016)		(0.042)		(0.030)		(0.012	
NS wrong interpretation	-0.118	*	0.148	*	0.508	***	-0.189	**	0.204	***	0.386	***
	(0.070)		(0.081)		(0.136)		(0.075)		(0.086)		(0.150)	
Cons	0.081		0.145		0.310		-0.209		-0.073		0.068	
	(0.203)		(0.283)		(0.530)		(0.225)		(0.247)		(0.413)	
R2	0.253		0.248		0.142		0.234		0.152		0.167	
Breush-Pagan test χ^2	214.988	***										

Note: HES = Healthy Eating Scale; Control (hunger) = control variable for hunger; Overweight or obese = dummy variables defining overweight and obese people according to the BMI; Frequency of Consumption = average frequency of consumption of the good; Values of the GI = value given to the GI in monetary terms (i.e., ΔWTP: WTP for GI – WTP for conventional products); FCQ_weight = FCQ item: "*It is important to me that the food I eat on a typical day…Help me to control my weight*"; FCQ_familiar = FCQ item: " *It is important to me that the food I eat on a typical day…*Is familiar"; WTP base = WTP that consumers usually have for the products; NS wrong interpretation = dummy variable that reflects an incorrect interpretation of the NS (i.e., considering a product "healthy" or "nutritionally valid" when have a NS = D and vice versa). Asterisks represent statistically significant at the levels: * p≤0.1; ** p≤0.05; *** p≤0.01

5.4. Discussion

Recently, the NS debate has gaining more and more importance at the scientific level (Stiletto et al., 2023), with research focusing on comparing the NS with other FOP labels in terms of consumers' perception and understanding (Egnell et al., 2018; Pettigrew et al., 2023), in determining its impact on healthy choices (Fuchs et al., 2022; Shin et al., 2023), in assessing the nutritional quality of foods based on their NS level (Poinsot et al., 2020), also considering GIs (Höhn et al., 2023), and in measuring the adherence of the NS with the Mediterranean diet products (Hafner & Pravst, 2021; Vlassopoulos et al., 2022). However, very low efforts have been spent to understand consumers' preferences and their WTP in a non-hypothetical setting (Mora-García et al., 2019), especially considering GI products (Stiletto & Trestini, 2022). The present study contributed to fill this gap by investigating consumers' WTP for NS labelled products in a real setting, comparing conventional and GI products. Results suggested that, on average, the NS label has an effect in guiding consumers' choices. Participants are willing to pay more for products with a positive NS, while they are found to lower their WTP for products considered to be reduced in consumption (NS=D), as widely supported in literature (Egnell et al., 2018; Julia & Hercberg, 2017b; Shin et al., 2023). However, this effect does not extend to all the products under investigation. In fact, results suggest that the presence of a negative NS does not affect consumers' WTP for GI products, or at least for the well-known ones, such as Parmigiano Reggiano. In this case, the negative effect of the NS is offset by the positive value attached to the PDO. This is opposite to what found in literature, as Stiletto & Trestini (2022) have shown that the halo effect of the Denomination (i.e., to extend the value given to a product characteristic, such as the Denomination, to the product itself) has not been found on less known GIs, as in the case of Casatella Trevigiana PDO or Asiago PDO. Indeed, literature stressed that price premium for GIs are generally product and GI dependent (Deselnicu et al., 2013; Leufkens, 2018), with Parmigiano Reggiano PDO and Parma ham PDO being the most virtuous examples of the strength of the (well known) Consortia label, perceived as a notorious brand by consumers (Arfini, 1999). Furthermore, it should be noticed that Parmigiano Reggiano PDO is a very well-known product in Italy, as found also in this study, being a hometown GI with high level of consumers loyalty and trust in this product (Arfini et al., 2006; Cozzi et al., 2019). As stressed by Zhang et al. (2023), consumers have usually higher purchase intention for hometown GI brand, being consumer-brand connection stronger for these products, with an

increased consumers' engagement with the GI brand. This partially explain why the Parmigiano Reggiano PDO "protects" the product from the negative effect of NS in the Italian market, while opposite results have been found for an equally famous GI, namely the Parma PDO Ham, in France, where the brand-consumer relationship is less strong (Chapter 5).

Yet, it is common ground that consumers perceived GIs as high-quality and authentic goods (Grunert & Aachmann, 2016). As stressed in the EU regulation 1151/2012, GIs are promoted and protected because of their superior quality, which is strictly linked to the territory in which they are made. The so-called "terroir", which ensures the GIs quality, combines natural and human factors, while the mere nutritional aspects are not considered. However, literature stressed a recent tendency of consumers to value GIs not only as traditional products, but also as healthy goods (Glogoveţan et al., 2022; Thøgersen & Nohlen, 2022), even if such superior attributes are not demonstrate. Nevertheless, most of animal-origin GIs gain a negative Nutri-Score grade, because of their content of fatty-acid, calories and sodium, even if they are usually additives-free or less processed products (Höhn et al., 2023). Presumably for this reason, the consumers in our sample, discovering that GIs have the same NS level (and thus very similar nutritional values) of their conventional counterparts, tend to shift value towards the conventional ones, reducing the value gap between the two products.

Furthermore, results stressed the important role of properly understand the FOP label to really steer consumers' choices towards healthier products. Indeed, consumers who wrongly evaluated the NS score (i.e., identifying as "healthy" a product with NS = D and as "unhealthy" a product with a NS = A) have increased their willingness to pay for the food negatively ranked by the NS label system and have reduced their WTP for those considered to be consumed frequently by the label. These findings are in line with previous studies (Stiletto & Trestini, 2022), which showed that, in countries where the NS is not adopted yet, only consumers familiar with this label were actually able to grasp its meaning, making choices consistent with the value expressed by the NS. The authors have indeed found a general positive propensity of Italian consumers to buy products considered "to be limited in consumption" when labeled with NS. However, those consumers who already knew the NS at the time of the experiment expressed a negative WTP for these products, consistent with the label's requirements. Being the FOP label context-dependent, consumers generally prefer the FOP labels already used in their country, because of their familiarity with the label (Santos et al., 2020). In Italy, the NutrInform battery (i.e., the FOP nutrition label proposed by the Italian Ministry of Health) and the Multiple Traffic Light Label system seem to perform better than the NS (Carruba et al., 2022;

Morgane Fialon et al., 2020) because consumers are more used to this labelling approach, even if some opposite results are found by Fialon et al. (2022). Also, as stressed by Włodarek & Dobrowolski (2022) in their comprehensive evaluation of the NS system, a misinterpretation of the NS label could lead to a reduction in the consumption of foods rich in essential amino-acids and other nutrients fundamental for the organism, as in the case of fatty marine fish, which are rich in ω−3 and ω−6 and thus with a strong antioxidant and anti-inflammatory power (Djuricic & Calder, 2021).

To reinforce this misinterpretation, the lack of a harmonized wording to indicate products with different NS values plays a fundamental role. As reported in section 2.4.1., the consumers in our sample describe the products evaluated in the experiment in a heterogeneous way based on their NS level, despite being provided with official information explaining the operation of the label. This reflects the jumble prevailing within the scientific community, with authors naming "unhealthy" and "nutritionally invalid" products with NS=D (or NS=E), although official guidelines now define these products as foods “to be limited in consumption”. Saying that the “overall nutritional value” of a product is “not good” is completely different from saying that that product should be "consumed in moderation", as found also by Hercberg et al. (2021). Likely, the first wording leads consumers to deem that a product with NS=D or NS=E should be always avoided, due to its low quality. The second, on the other hand, helps them to understand to what extent they must consume that specific product to follow a balance diet. This second wording is in line with the Mediterranean diet, with suggest the frequency of consumption of different goods, and the NS, if correctly defined, is in line with this diet precepts, as also found by Vlassopoulos et al. (2022). Therefore, a clear way of interpreting the NS label should be defined and provided to consumers, especially in the period following its mandatory introduction, considering that costumers in different countries have different levels of familiarity with the label, a key-factor in the objective understanding of the labels (Santos et al., 2020).

Finally, results stressed the role of psychographic and demographic variables in explaining consumers’ WTP for NS labelled products. As expected, the NS has a booster effect in guiding healthy-choices for consumers who are more prone to follow a healthy and balanced lifestyle and/or to control their weight through the diet, in line with the literature (Gassler et al., 2022). On the contrary, the older consumers seem to be the less willing to pay a price premium for products with positive NS. Elderly individuals are generally found not to follow a balanced and healthy diet, due to physical difficulties in eating and swallowing, and preferring repeated and

standardized purchases (Bostic & McClain, 2017; Caso & Vecchio, 2022). Besides, income has found to be a key-factor driving consumers' choices, increasing consumers' WTP for both positively (NS=A) and medium scored (NS=C) labelled products. Several authors reported that low-income people tend to have a less healthy diet, being price the most important driver in food purchasing (Braveman et al., 2005; Darmon & Drewnowski, 2008; Dowler, 2001).

5.5. Conclusion

In conclusion, this study found that the NS label generates premiums and penalties in consumers' willingness to pay respectively for A and D scores, coherently with the expectations. Consumers are generally willing to pay more for products with positive NS (NS=A), while they are found to reduce their WTP for negatively labeled products (NS=D). Broadly speaking, GIs seem to suffer from the presence of the NS. Consumers, discovering thatGIs have the same nutritional quality (expressed by the NS grade) as their conventional counterparts, diminishes the gap between GIs and conventional products, reducing their WTP for these goods. However, the reputation of the well-known GIs (such as Parmigiano Reggiano PDO) and the high-quality value associated to these products seems to justify the ability to compensate for the decrease in WTP found for products with negative NS. Yet, despite the NS has found to be self-explanatory in most of the cases, the misunderstanding of the label seems to undermine the effectiveness of this tool. This is particularly true in countries where the NS is not adopted yet, as in Italy, where consumers are not familiar with the label. Also, a lack of alignment of the scientific community in describing this label and defining products with different NS levels reinforces the halo around the NS, making communication less effective and direct. Therefore, homogenous and effective communication strategies are needed within the EU countries to reach the F2F goals and for the NS to be an efficient nutrition tool.

References

Adriouch, S., Julia, C., Kesse-Guyot, E., Ducrot, P., Péneau, S., Méjean, C., Assmann, K. E., Deschasaux, M., Hercberg, S., Touvier, M., & Fezeu, L. K. (2017). Association between a dietary quality index based on the food standard agency nutrient profiling system and cardiovascular disease risk among French adults. *International Journal of Cardiology*, *234*, 22–27. https://doi.org/10.1016/j.ijcard.2017.02.092

Ahn, C., & Lee, C. G. (2022). Effect of NUTRI-SCORE labeling on sales of food items in stores at sports and non-sports facilities. *Preventive Medicine Reports*, *29*(February), 101919. https://doi.org/10.1016/j.pmedr.2022.101919

Altamore, L., Ingrassia, M., Columba, P., Chironi, S., & Bacarella, S. (2020). Italian Consumers' Preferences for Pasta and Consumption Trends: Tradition or Innovation? *Journal of International Food and Agribusiness Marketing*, *32*(4), 337–360. https://doi.org/10.1080/08974438.2019.1650865

Ares, G., Varela, F., Machin, L., Antúnez, L., Giménez, A., Curutchet, M. R., & Aschemann-Witzel, J. (2018). Comparative performance of three interpretative front-of-pack nutrition labelling schemes: Insights for policy making. *Food Quality and Preference*, *68*, 215–225. https://doi.org/10.1016/J.FOODQUAL.2018.03.007

Arfini, F. (1999). The value of typical products: the case of Prosciutto di Parma and Parmigiano Reggiano cheese. *The Socio-Economics of Origin Labelled Products: Spatial, Institutional and Co-Ordination Aspects*, 78–97. http://ageconsearch.umn.edu/record/241032/files/Arfini _1999_ The value of typical products.pdf

Arfini, F., Boccaletti, S., Giacomini, C., Moro, D., & Sckokai, P. (2006). Case studies: Parmigiano Reggiano. *DG JRC/IPTS*.

Ballarini, G. (2022). Italiani consumatori di formaggio. *Ruminantia*.

Becker, G. M., DeGroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Experiments in Environmental Economics*, *9*(1964), 226–232.

Benfatto, L. (2021). Piadina protagonista sulla tavola: crescita record per le aziende del settore. *Ilsole24ore*.

Bilal, M., & Oxentenko, A. S. (2020). The Impact of Twitter: Why Should You Get Involved, and Tips and Tricks to Get Started. *American Journal of Gastroenterology*, *115*(10), 1549–1552. https://doi.org/10.14309/ajg.0000000000000763

Blasco, M. M., & Jiménez-Morales, M. (2021). Breakfast food advertising and prevention of

obesity: Analysis of the nutritional value of the products and discursive strategies used in the breakfast ads from 2015 to 2019. *Nutrients*, *13*(1), 1–9. https://doi.org/10.3390/nu13010231

Borgmeier, I., & Westenhoefer, J. (2009). *Impact of different food label formats on healthiness evaluation and food choice of consumers: a randomized-controlled study*. https://doi.org/10.1186/1471-2458-9-184

Bostic, S. M., & McClain, A. C. (2017). Older adults' cooking trajectories: shifting skills and strategies. *British Food Journal*, *119*(5), 1102–1115. https://doi.org/10.1108/BFJ-09-2016-0436

Boztuğ, Y., Juhl, H. J., Elshiewy, O., & Jensen, M. B. (2015). Consumer response to monochrome Guideline Daily Amount nutrition labels. *Food Policy*, *53*, 1–8. https://doi.org/10.1016/j.foodpol.2015.03.002

Braesco, V., Ros, E., Govindji, A., Bianchi, C., Becqueriaux, L., & Quick, B. (2022). A Slight Adjustment of the Nutri-Score Nutrient Profiling System Could Help to Better Reflect the European Dietary Guidelines Regarding Nuts. *Nutrients*, *14*(13). https://doi.org/10.3390/nu14132668

Braveman, P. A., Cubbin, C., Egerter, S., Chideya, S., Marchi, K. S., Metzler, M., & Posner, S. (2005). Socioeconomic Status in Health Research. *Jama*, *294*(22), 2879. https://doi.org/10.1001/jama.294.22.2879

Bronnmann, J., & Hoffmann, J. (2018). Product differentiation in the German soft drink market: which attributes matter? *Applied Economics Letters*, *25*(14), 968–971. https://doi.org/10.1080/13504851.2017.1388906

Cameron, A., & Trivedi, P. (2005). *Microeconometrics: Methods and Applications*. https://doi.org/10.1017/CBO9780511811241

Campos, S., Doxey, J., & Hammond, D. (2011). Nutrition labels on pre-packaged foods: A systematic review. In *Public Health Nutrition* (Vol. 14, Issue 8, pp. 1496–1506). https://doi.org/10.1017/S1368980010003290

Capacci, S., Mazzocchi, M., Shankar, B., Macias, B., Verbeke, W., Ja Pérez-Cueto, F., Kozioł-Kozakowska, A., Piórecka, B., Niedzwiedzka, B., D'addesa, D., Saba, A., Turrini, A., Aschemann-Witzel, J., Bech-Larsen, T., Strand, M., Smillie, L., Wills, J., & Traill, B. (2012). Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness. *Nutrition Reviews*, *70*(3), 188–200. https://doi.org/10.1111/j.1753-4887.2011.00442.x

Caracciolo, F., Cembalo, L., & Pomarici, E. (2013). The hedonic price for an Italian grape variety. *Italian Journal of Food Science*, *25*(3). https://flore.unifi.it/retrieve/handle/2158/820872/26648/IJFS253.rar#page=42

Carlucci, D., De Gennaro, B., Roselli, L., & Seccia, A. (2014). E-commerce retail of extra virgin olive oil: An hedonic analysis of Italian Smes supply. *British Food Journal*, *116*(10), 1600–1617. https://doi.org/10.1108/BFJ-05-2013-0138

Carruba, M. O., Caretto, A., De Lorenzo, A., Fatati, G., Ghiselli, A., Lucchin, L., Maffeis, C., Malavazos, A., Malfi, G., Riva, E., Ruocco, C., Santini, F., Silano, M., Valerio, A., Vania, A., & Nisoli, E. (2022). *Front-of-pack (FOP) labelling systems to improve the quality of nutrition information to prevent obesity: NutrInform Battery vs Nutri-Score*. *27*, 1575–1584. https://doi.org/10.1007/s40519-021-01316-z

Carter, O., Mills, B. W., Lloyd, E., & Phan, T. (2013). An independent audit of the Australian food industry's voluntary front-of-pack nutrition labelling scheme for energy-dense nutrition-poor foods. *European Journal of Clinical Nutrition*, *67*, 31–35. https://doi.org/10.1038/ejcn.2012.179

Caso, G., & Vecchio, R. (2022). Factors influencing independent older adults (un)healthy food choices: A systematic review and research agenda. *Food Research International*, *158*(February), 111476. https://doi.org/10.1016/j.foodres.2022.111476

Cavallo, C., Caracciolo, F., Cicia, G., & Del Giudice, T. (2018). Extra-virgin olive oil: are consumers provided with the sensory quality they want? A hedonic price model with sensory attributes. *Journal of the Science of Food and Agriculture*, *98*(4), 1591–1598. https://doi.org/10.1002/JSFA.8633

Cawley, J., Sweeney, M. J., Sobal, J., Just, D. R., Kaiser, H. M., Schulze, W. D., Wethington, E., & Wansink, B. (2015). The impact of a supermarket nutrition rating system on purchases of nutritious and less nutritious foods. *Public Health Nutrition*, *18*(1), 8–14. https://doi.org/10.1017/S1368980014001529

Cei, L., Defrancesco, E., & Stefani, G. (2018). From geographical indications to rural development: A review of the economic effects of European Union policy. *Sustainability (Switzerland)*, *10*(10). https://doi.org/10.3390/su10103745

Chang, J. B., Lusk, J. L., & Norwood, B. F. (2009). How closely do hypothetical surveys and laboratory experiments predict field behavior? *American Journal of Agricultural Economics*, *91*(2), 518–534. https://doi.org/10.1111/j.1467-8276.2008.01242.x

Chantal, J., Touvier, M., Kesse-Guyot, E., Galan, P., & Hercberg, S. (2022). Nutri-Score in tug-of-

war between public health and economic interests in the European Union. *Nature Food*, *3*(181).

Cirera, X., & Masset, E. (2010). Income distribution trends and future food demand. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2821–2834. https://doi.org/10.1098/rstb.2010.0164

Combris, P., Lecocq, S., & Visser, M. (1997). Estimation of a Hedonic Price Equation for Bordeaux Wine: Does Quality Matter? *The Economic Journal*, *107*(441), 390–402. https://doi.org/10.1111/j.0013-0133.1997.165.x

Commission, E. (2021). *Study on economic value of EU quality schemes, geographical indications (GIs) and traditional specialities guaranteed (TSGs) : final report*. Publications Office. https://doi.org/doi/10.2762/396490

Costanigro, M., McCluskey, J. J., & Mittelhammer, R. C. (2007). Segmenting the Wine Market Based on Price: Hedonic Regression when Different Prices mean Different Products. *Journal of Agricultural Economics*, *58*(3), 454–466. https://doi.org/10.1111/j.1477-9552.2007.00118.x

Cowburn, G., & Stockley, L. (2005). Consumer understanding and use of nutrition labelling: a systematic review. *Public Health Nutrition*, *8*(1), 21–28. https://doi.org/10.1079/phn2005666

Cozzi, E., Donati, M., Mancini, M. C., Guareschi, M., & Veneziani, M. (2019). PDO parmigiano reggiano cheese in Italy. *Sustainability of European Food Quality Schemes: Multi-Performance, Structure, and Governance of PDO, PGI, and Organic Agri-Food Systems*, 427–449. https://doi.org/10.1007/978-3-030-27508-2_22

Crescenzi, R., De Filippis, F., Giua, M., & Vaquero-Piñeiro, C. (2022). Geographical Indications and local development: the strength of territorial embeddedness. *Regional Studies*, *56*(3), 381–393. https://doi.org/10.1080/00343404.2021.1946499

Crosetto, P., Lacroix, A., Muller, L., & Ruffieux, B. (2017). Modifications of food purchases in response to five nutrition simplified labelling. *Cahiers de Nutrition et de Dietetique*, *52*(3), 129–133. https://doi.org/10.1016/j.cnd.2017.04.002

Darby, M. R., & Karni, E. (1973). Free competition and the optimal amount of fraud. *The Journal of Law and Economics*, *16*(1), 67–88.

Darmon, N., & Drewnowski, A. (2008). Does social class predict diet quality? *American Journal of Clinical Nutrition*, *87*(5), 1107–1117. https://doi.org/10.1093/ajcn/87.5.1107

De Bauw, M., De La Revilla, L. S., Poppe, V., Matthys, C., & Vranken, L. (2022). Digital nudges to

stimulate healthy and pro-environmental food choices in E-groceries. *Appetite*, *172*(July 2021), 105971. https://doi.org/10.1016/j.appet.2022.105971

De Bauw, M., Matthys, C., Poppe, V., Franssens, S., & Vranken, L. (2021a). A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. *Food Quality and Preference*, *93*(April), 104276. https://doi.org/10.1016/j.foodqual.2021.104276

De Bauw, M., Matthys, C., Poppe, V., Franssens, S., & Vranken, L. (2021b). A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. *Food Quality and Preference*, *93*, 104276. https://doi.org/10.1016/J.FOODQUAL.2021.104276

De Temmerman, J., Heeremans, E., Slabbinck, H., & Vermeir, I. (2021). The impact of the Nutri-Score nutrition label on perceived healthiness and purchase intentions. *Appetite*, *157*, 104995. https://doi.org/10.1016/J.APPET.2020.104995

Delamaire, C., Bossard, C., & Julia, C. (2008). Perceptions, connaissances et attitudes en matière d'alimentation. In *Baromètre santé nutrition 2008* (pp. 80–116).

Delhaize. (2022). *Producten met een verbeterde Nutri-Score*. https://www.delhaize.be/nl/nutriscore-update, accessed 28 July 2022

Deschamps, V., Julia, C., Salanave, B., Verdot, C., Hercberg, S., & Castetbon, K. (2015). Score de qualité nutritionnelle des aliments dela Food Standards Agency appliqué aux consommationsalimentaires individuelles des adultes en France. *Bulletin Epidémiologique Hebdomadaire*, 466–475.

Deschasaux, M., Julia, C., Kesse-Guyot, E., Lécuyer, L., Adriouch, S., Méjean, C., Ducrot, P., Péneau, S., Latino-Martel, P., Fezeu, L. K., Fassier, P., Hercberg, S., & Touvier, M. (2017). Are self-reported unhealthy food choices associated with an increased risk of breast cancer? Prospective cohort study using the British Food Standards Agency nutrient profiling system. *BMJ Open*, *7*(6). https://doi.org/10.1136/bmjopen-2016-013718

Deselnicu, O. C., Costanigro, M., Souza-Monteiro, D. M., & McFadden, D. T. (2013). A Meta-Analysis of Geographical Indication Food Valuation Studies: What Drives the Premium for Origin-Based Labels? *Journal of Agricultural and Resource Economics*, *2*, 204–219.

Di Vita, G., Caracciolo, F., Cembalo, L., Pomarici, E., & D'Amico, M. (2015). Drinking wine at home: Hedonic analysis of sicilian wines using quantile regression. *American Journal of Applied Sciences*, *12*(10), 679–688. https://doi.org/10.3844/ajassp.2015.679.688

Djuricic, I., & Calder, P. C. (2021). Beneficial outcomes of omega-6 and omega-3

polyunsaturated fatty acids on human health: An update for 2021. *Nutrients*, *13*(7). https://doi.org/10.3390/nu13072421

Dobbs, R., & Manyika, J. (2015). The Obesity Crisis. *The Cairo Review of Global Affairs*, 44–57. https://doi.org/10.1159/000355993

Dowler, E. (2001). Inequalities in diet and physical activity in Europe. *Public Health Nutrition*, *4*(2b), 701–709. https://doi.org/10.1079/phn2001160

Dréano-Trécant, L., Egnell, M., Hercberg, S., Galan, P., Soudon, J., Fialon, M., Touvier, M., Kesse-Guyot, E., & Julia, C. (2020). Performance of the front-of-pack nutrition label nutri-score to discriminate the nutritional quality of foods products: A comparative study across 8 european countries. *Nutrients*, *12*(5). https://doi.org/10.3390/nu12051303

Dubois, P., Albuquerque, P., Allais, O., Bonnet, C., Bertail, P., Combris, P., Lahlou, S., Rigal, N., Ruffieux, B., & Chandon, P. (2020). Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: evidence from a large-scale randomized controlled trial. *Journal of the Academy of Marketing Science*. https://doi.org/10.1007/s11747-020-00723-5

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L., Hercberg, S., & Péneau, S. (2015a). Effectiveness of Front-Of-Pack Nutrition Labels in French Adults: Results from the NutriNet-Santé Cohort Study. *PLoS One, 10*(10). https://doi.org/10.1371/journal.pone.0140898

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L. K., Hercberg, S., & Péneau, S. (2015b). Objective Understanding of Front-of-Package Nutrition Labels among Nutritionally At-Risk Individuals. *Nutrients*, *7*, 7106–7125. https://doi.org/10.3390/nu7085325

Edenbrandt, A. K., Smed, S., & Jansen, L. (2018). A hedonic analysis of nutrition labels across product types and countries. *European Review of Agricultural Economics*, *45*(1), 101–120. https://doi.org/10.1093/erae/jbx025

Egnell, M., Ducrot, P., Touvier, M., Allès, B., Hercberg, S., Kesse-Guyot, E., & Julia, C. (2018). Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: Comparisons with other format labels. *PLoS ONE*, *13*(8). https://doi.org/10.1371/journal.pone.0202095

Egnell, M., Galan, P., Fialon, M., Touvier, M., Péneau, S., Kesse-Guyot, E., Hercberg, S., & Julia, C. (2021). The impact of the Nutri-Score front-of-pack nutrition label on purchasing intentions of unprocessed and processed foods: post-hoc analyses from three

randomized controlled trials. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 1–12. https://doi.org/10.1186/s12966-021-01108-9

Elizabeth, L., Machado, P., Zinöcker, M., Baker, P., & Lawrence, M. (2020). Ultra-processed food and adverse health outcomes. *Nutrients*, *12*(7). https://doi.org/10.1136/bmj.l2289

European Commission. (2020a). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system*.

European Commission. (2020b). *Geographical Indications - a Europeam tresure worth €75 billion*.

FAO. (2021). *The Nutrition and Health Potential of Geographical Indication Foods*.

Fedoseeva, S. (2020). (Dynamic) willingness to pay and e-commerce: Insights from sparkling wine sector in Russia. *Journal of Retailing and Consumer Services*, *57*, 102180. https://doi.org/10.1016/J.JRETCONSER.2020.102180

Fialon, M, Salas-Salvadó, J., Babio, N., Touvier, M., Hercberg, S., & Galan, P. (2021). Is fop nutrition label nutri-score well understood by consumers when comparing the nutritional quality of added fats, and does it negatively impact the image of olive oil? *Foods*, *10*(9). https://doi.org/10.3390/foods10092209

Fialon, Morgane, Egnell, M., Talati, Z., Galan, P., Dréano-Trécant, L., Touvier, M., Pettigrew, S., Hercberg, S., & Julia, C. (2020). Effectiveness of different front-of-pack nutrition labels among italian consumers: Results from an online randomized controlled trial. *Nutrients*, *12*(8), 1–13. https://doi.org/10.3390/nu12082307

Fialon, Morgane, Serafini, M., Galan, P., Kesse-Guyot, E., Touvier, M., Deschasaux-Tanguy, M., Sarda, B., Hercberg, S., Nabec, L., & Julia, C. (2022). Nutri-Score and NutrInform Battery: Effects on Performance and Preference in Italian Consumers. *Nutrients*, *14*(17), 1–12. https://doi.org/10.3390/nu14173511

Folkvord, F., Bergmans, N., & Pabian, S. (2021). The effect of the nutri-score label on consumer's attitudes, taste perception and purchase intention: An experimental pilot study. *Food Quality and Preference*, *94*, 104303. https://doi.org/10.1016/j.foodqual.2021.104303

Forner, F., Volkhardt, I., Meier, T., Christen, O., & Stangl, G. I. (2021). The nutriRECIPE-Index – development and validation of a nutrient-weighted index for the evaluation of recipes. *BMC Nutrition*, *7*(1). https://doi.org/10.1186/s40795-021-00483-7

Fuchs, K. L., Lian, J., Michels, L., Mayer, S., Toniato, E., & Tiefenbeck, V. (2022). Effects of Digital Food Labels on Healthy Food Choices in Online Grocery Shopping. *Nutrients*, *14*(10), 2044. http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=84403754&site=ehost-live

Gassler, B., Faesel, C. K., & Moeser, A. (2022). Toward a differentiated understanding of the effect of Nutri-Score nutrition labeling on healthier food choices. *Agribusiness*, *39*(1), 28–50. https://doi.org/10.1002/AGR.21762

Glogoveţan, A. I., Dabija, D. C., Fiore, M., & Pocol, C. B. (2022). Consumer Perception and Understanding of European Union Quality Schemes: A Systematic Literature Review. *Sustainability (Switzerland)*, *14*(3), 1–16. https://doi.org/10.3390/su14031667

Graham, D. J., Lucas-Thompson, R. G., Mueller, M. P., Jaeb, M., & Harnack, L. (2017). Impact of explained v. unexplained front-of-package nutrition labels on parent and child food choices: A randomized trial. *Public Health Nutrition*, *20*(5), 774–785. https://doi.org/10.1017/S1368980016002676

Grunert, K. G., & Aachmann, K. (2016). Consumer reactions to the use of EU quality labels on food products: Areview of the literature. *Food Control*, *59*, 178–187. https://doi.org/10.1016/j.foodcont.2015.05.021

Grunert, K. G., Fernández-Celemín, L., Wills, J. M., Bonsmann, S. S. G., & Nureeva, L. (2010). Use and understanding of nutrition information on food labels in six European countries. *Journal of Public Health*, *18*(3), 261–277. https://doi.org/10.1007/s10389-009-0307-0

Grunert, K. G., & Wills, J. M. (2007). A review of European research on consumer response to nutrition information on food labels. *Journal of Public Health*, *15*(5), 385–399. https://doi.org/10.1007/s10389-007-0101-9

Habib, S. H., & Saha, S. (2010). Burden of non-communicable disease: Global overview. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *4*(1), 41–47. https://doi.org/10.1016/j.dsx.2008.04.005

Hafner, E., & Pravst, I. (2021). Evaluation of the Ability of Nutri-Score to Discriminate the Nutritional Quality of Prepacked Foods Using a Sale-Weighting Approach. *Foods*, *10*, 1689. https://doi.org/10.3390/foods10081689

Hall, K. D., Ayuketah, A., Brychta, R., Cai, H., Cassimatis, T., Chen, K. Y., Chung, S. T., Costa, E., Courville, A., Darcey, V., Fletcher, L. A., Forde, C. G., Gharib, A. M., Guo, J., Howard, R., Joseph, P. V., McGehee, S., Ouwerkerk, R., Raisinger, K., … Zhou, M. (2019). Ultra-

Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake. *Cell Metabolism*, *30*(1), 67-77.e3. https://doi.org/10.1016/j.cmet.2019.05.008

Hamlin, R. (2015). Front of Pack Nutrition Labelling, Nutrition, Quality and Consumer Choices. *Current Nutrition Reports*, *4*(4), 323–329. https://doi.org/10.1007/s13668-015-0147-1

Hawkes, C., & Popkin, B. M. (2015). Can the sustainable development goals reduce the burden of nutrition-related non-communicable diseases without truly addressing major food system reforms? *BMC Medicine*, *13*(1), 1–3. https://doi.org/10.1186/s12916-015-0383-7

Hercberg, S., Touvier, M., & Salas-salvado, J. (2022). The Nutri-Score nutrition label. *International Journal for Vitamin and Nutrition Research*, *92*(3–4), 147–157.

Hercberg, S., Touvier, M., & Salas-Salvado, J. (2021). The Nutri-Score nutrition label. *Https://Doi.Org/10.1024/0300-9831/A000722*, *92*(3–4), 147–157. https://doi.org/10.1024/0300-9831/A000722

Hillmann, H., & Hofmann, T. (2016). Quantitation of Key Tastants and Re-engineering the Taste of Parmesan Cheese. *Journal of Agricultural and Food Chemistry*, *64*(8), 1794–1805. https://doi.org/10.1021/acs.jafc.6b00112

Höhn, G. L., Huysmans, M., & Crombez, C. (2023). Healthy food traditions? Nutritional quality and food composition of EU geographical indications. *Q Open*, *3*(1), 1–20. https://doi.org/10.1093/qopen/qoad014

Holmes, T. P., Adamowicz, W. L., & Carlsson, F. (2017). Choice Experiments. In *A Primer on Nonmarket Valuation*.

Iotti, M., & Bonazzi, G. (2014). The application of Life Cycle Cost (LCC) approach to quality food production: A comparative analysis in the parma pdo ham sector. *American Journal of Applied Sciences*, *11*(9), 1492–1506. https://doi.org/10.3844/ajassp.2014.1492.1506

ISMEA. (2019). *Rapporto 2019 Ismea-Qualivita sulle produzioni agroalimentari e vitivinicole italiane DOP, IGP e STG*.

ISMEA. (2020). *Rapporto Ismea - Qualivita 2020*.

ISMEA. (2021). *RAPPORTO ISMEA - QUALIVITA 2021 sulle produzioni vitivinicole e agroalimentari DOP Italia*.

Jiménez-Morales, M., & Montaña Blasco, M. (2021). Presence and strategic use of the Mediterranean Diet in food marketing: Analysis and association of nutritional values and advertising claims from 2011 to 2020. *NFS Journal*, *24*(April), 1–6. https://doi.org/10.1016/j.nfs.2021.04.003

Journo, L. J., & Snipes, K. (2018). FRANCE RETAIL FOODS 2018. In *USDA Foreign Agricultural Service*.

Julia, C., Blanchet, O., Méjean, C., Péneau, S., Ducrot, P., Allès, B., Fezeu, L. K., Touvier, M., Kesse-Guyot, E., Singler, E., & Hercberg, S. (2016). Impact of the front-of-pack 5-colour nutrition label (5-CNL) on the nutritional quality of purchases: An experimental study. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1), 1–9. https://doi.org/10.1186/s12966-016-0416-4

Julia, C., Ducrot, P., Péneau, S., Deschamps, V., Méjean, C., Fézeu, L., Touvier, M., Hercberg, S., & Kesse-Guyot, E. (2015). Discriminating nutritional quality of foods using the 5-Color nutrition label in the French food market: Consistency with nutritional recommendations. *Nutrition Journal*, *14*(1), 1–12. https://doi.org/10.1186/s12937-015-0090-4

Julia, C., & Hercberg, S. (2016). Research and lobbying conflicting on the issue of a front-of-pack nutrition labelling in France. *Archives of Public Health*, *74*(1), 1–5. https://doi.org/10.1186/s13690-016-0162-8

Julia, C., & Hercberg, S. (2017a). Development of a new front-of-pack nutrition label in France: the five-colour Nutri-Score. *Public Health Panorama*, *03*(04), 712–725.

Julia, C., & Hercberg, S. (2017b). Nutri-Score: evidence of the effective-ness of the French front-of-pack nutrition label. *Ernahrungs Umschau*, *64*(12), 181–187. https://doi.org/10.4455/eu.2017.048

Julia, C., Méjean, C., Touvier, M., Péneau, S., Lassale, C., Ducrot, P., Hercberg, S., & Kesse-Guyot, E. (2016). Validation of the FSA nutrient profiling system dietary index in French adults—findings from SUVIMAX study. *European Journal of Nutrition*, *55*(5), 1901–1910. https://doi.org/10.1007/s00394-015-1006-y

Julia, C., Péneau, S., Buscail, C., Gonzalez, R., Touvier, M., Hercberg, S., & Kesse-Guyot, E. (2017). Perception of different formats of front-of-pack nutrition labels according to sociodemographic, lifestyle and dietary factors in a French population: Cross-sectional study among the NutriNet-Santé cohort participants. *BMJ Open*, *7*(6). https://doi.org/10.1136/bmjopen-2017-016108

Katsouri, E., Magriplis, E., Zampelas, A., Drosinos, E. H., & Nychas, G.-J. (2021). Dietary intake assessment of pre-packed graviera cheese in greece and nutritional characterization using the nutri-score front of pack label scheme. *Nutrients*, *13*(2), 1–15. https://doi.org/10.3390/nu13020295

Kelly, B., Hughes, C., Chapman, K., Louie, J. C. Y., Dixon, H., Crawford, J., King, L., Daube, M., & Slevin, T. (2009). Consumer testing of the acceptability and effectiveness of front-of-pack food labelling systems for the Australian grocery market. *Health Promotion International*, *24*(2), 120–129. https://doi.org/10.1093/heapro/dap012

Kennedy, P. E. (1981). Estimation with correctly interpreted dummy variables in semilogarithmic equations. *The American Economic Review*, *71*(4), 801.

Kissock, K. R., Vieux, F., Mathias, K. C., Drewnowski, A., Seal, C. J., Masset, G., Smith, J., Mejborn, H., McKeown, N. M., & Beck, E. J. (2022). Aligning nutrient profiling with dietary guidelines: modifying the Nutri-Score algorithm to include whole grains. *European Journal of Nutrition*, *61*(1), 541–553. https://doi.org/10.1007/s00394-021-02718-6

Koppel, K., & Chambers, D. H. (2012). Flavor Comparison of Natural Cheeses Manufactured in Different Countries. *Journal of Food Science*, *77*(5), 177–187. https://doi.org/10.1111/j.1750-3841.2012.02674.x

Lancaster, K. J. (1966). A New Approach to Consumer Theory. *Current*, *74*(2), 132–157.

Leufkens, D. (2018). The problem of heterogeneity between protected geographical indications: A meta-analysis. *British Food Journal*, *120*, 2843–2856.

List, J. A., & Gallet, C. A. (2001). What Experimental Protocol Influence Disparities Between Actual and Hypothetical Stated Values? Evidence from a Meta-Analysis. In *Environmental and Resource Economics* (Vol. 20).

Lombardi, A., Vecchio, R., Borrello, M., Caracciolo, F., & Cembalo, L. (2019). Willingness to pay for insect-based food: The role of information and carrier. *Food Quality and Preference*, *72*(September 2018), 177–187. https://doi.org/10.1016/j.foodqual.2018.10.001

Lucas, R. E. B. (1975). HEDONIC PRICE FUNCTIONS. *Economic Inquiry*, *13*(2), 157–178. https://doi.org/10.1111/J.1465-7295.1975.TB00985.X

Lusk, J. L., Alexander, C., & Rousu, M. C. (2007). Designing experimental auctions for marketing research: The effect of values, distributions, and mechanisms on incentives for truthful bidding. *Review of Marketing Science*, *5*(February). https://doi.org/10.2202/1546-5616.1059

Lusk, J. L., & Shogren, J. F. (2007). Experimental Auctions: Methods and Applications in Economic and Marketing Research. In *Quantitative Methods for Applied Economics and Business Research* (p. 316). Cambridge University Press (CUP).

Lynch Jr, J. G. (1982). On the external validity of experiments in consumer research. *Journal of Consumer Research*, *9*(3), 225–239.

Manzi, P., Gabriella, M., Costanzo, D., & Ritota, M. (2021). Content and Nutritional Evaluation of Zinc in PDO and Traditional Italian Cheeses. *Molecules*, *26*(20), 6300.

Mazzù, M. F., Romani, S., & Gambicorti, A. (2020). Effects on consumers' subjective understanding of a new front-of-pack nutritional label: a study on Italian consumers. *Https://Doi.Org/10.1080/09637486.2020.1796932*, *72*(3), 357–366. https://doi.org/10.1080/09637486.2020.1796932

Mora-García, C. A., Tobar, L. F., & Young, J. C. (2019). The effect of randomly providing nutri-score information on actual purchases in Colombia. *Nutrients*, *11*(3). https://doi.org/10.3390/nu11030491

Nagle, M. G., & Osorio, T. D. (1993). The tuning of human photopigments may minimize red-green chromatic signals in natural conditions. *Proceedings of the Royal Society B: Biological Sciences*, *252*(1335), 209–213. https://doi.org/10.1098/rspb.1993.0067

Neal, B., Crino, M., Dunford, E., Gao, A., Greenland, R., Li, N., Ngai, J., Ni Mhurchu, C., Pettigrew, S., Sacks, G., Webster, J., & Y Wu, J. H. (2017). Effects of Different Types of Front-of-Pack Labelling Information on the Healthiness of Food Purchases-A Randomised Controlled Trial. *Nutrients*, *9*(12). https://doi.org/10.3390/nu9121284

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M. E., Achoki, T., Albuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., Guzman, N. A., … Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *384*(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8

Noussair, C., Robin, S., & Ruffieux, B. (2004). Revealing consumers' willingness-to-pay: A comparison of the BDM mechanism and the Vickrey auction. *Journal of Economic Psychology*, *25*(6), 725–741. https://doi.org/10.1016/J.JOEP.2003.06.004

Nseir, W., Nassar, F., & Assy, N. (2010). Soft drinks consumption and nonalcoholic fatty liver disease. *World Journal of Gastroenterology*, *16*(21), 2579–2588. https://doi.org/10.3748/wjg.v16.i21.2579

Oczkowski, E. (1994). A HEDONIC PRICE FUNCTION FOR AUSTRALIAN PREMIUM TABLE WINE*. *Australian Journal of Agricultural Economics*, *38*(1), 93–110. https://doi.org/10.1111/j.1467-8489.1994.tb00721.x

Onwezen, M. C., Reinders, M. J., Verain, M. C. D., & Snoek, H. M. (2019). The development of a single-item Food Choice Questionnaire. *Food Quality and Preference*, *71*(May 2018), 34–

45. https://doi.org/10.1016/j.foodqual.2018.05.005

Pettigrew, S., Jongenelis, M. I., Jones, A., Hercberg, S., & Julia, C. (2023). An 18-country analysis of the effectiveness of five front-of-pack nutrition labels. *Food Quality and Preference*, *104*. https://doi.org/10.1016/J.FOODQUAL.2022.104691

Poetschki, K., Peerlings, J., & Dries, L. (2021). The impact of geographical indications on farm incomes in the EU olives and wine sector. *British Food Journal*, *123*(13), 579–598. https://doi.org/10.1108/BFJ-12-2020-1119

Poinsot, R., Vieux, F., Dubois, C., Perignon, M., Méjean, C., & Darmon, N. (2020). Nutritional quality of vegetarian and non-vegetarian dishes at school: Are nutrient profiling systems sufficiently informative? *Nutrients*, *12*(8), 1–17. https://doi.org/10.3390/nu12082256

Qualivita. (2022). *Cresce la filiera IGP della Pasta di Gragnano: produzione + 84% nell'ultimo triennio*. https://www.qualivita.it/news/cresce-la-filiera-igp-della-pasta-di-gragnano-produzione-84-nellultimo-triennio/

Rahkovsky, I., Lin, B. H., Lin, C. T. J., & Lee, J. Y. (2013). *Effects of the Guiding Stars Program on purchases of ready-to-eat cereals with different nutritional attributes*. Food Policy. https://doi.org/10.1016/j.foodpol.2013.08.013

Rayner, M., Scarborough, P., Heart, B., & Health, F. (2009). The UK Ofcom Nutrient Profiling Model. In *UK Ofcom*. https://www.ndph.ox.ac.uk

Resano-Ezcaray, H., & Sanjuàn-Lòpez, I. A. (2008). An hedonic approach applied to scanner data on cured ham purchases in Spain. *12th EAAE Congress 'People, Food and Environments: Global Trends and European Strategies.'* https://doi.org/10.22004/AG.ECON.44383

Resano-Ezcaray, H., Sanjuàn-Lòpez, I. A., & Albisu-Aguado, L. M. (2010). Combining Stated and Revealed Preferences on Typical Food Products: The Case of Dry-Cured Ham in Spain. *Journal of Agricultural Economics*, *61*(3), 480–498. https://doi.org/10.1111/j.1477-9552.2010.00250.x

Roheim, C. A., Asche, F., & Santos, J. I. (2011). The elusive price premium for ecolabelled products: Evidence from seafood in the UK market. *Journal of Agricultural Economics*, *62*(3), 655–668. https://doi.org/10.1111/j.1477-9552.2011.00299.x

Romero Ferreiro, C., Lora Pablos, D., & Gómez de la Cámara, A. (2021). Two dimensions of nutritional value: Nutri-score and nova. *Nutrients*, *13*(8). https://doi.org/10.3390/nu13082783

Rosen, S. (1974). *Hedonic Prices and Implicit Markets: Product Differentiation in Pure*

Competition. http://www.journals.uchicago.edu/t-and-c

Sacks, G., Rayner, M., & Swinburn, B. (2009). Impact of front-of-pack "traffic-light" nutrition labelling on consumer food purchases in the UK. *Health Promotion International*, *24*(4), 344–352. https://doi.org/10.1093/heapro/dap032

Sacks, G., Tikellis, K., Millar, L., & Swinburn, B. (2011). Impact of "traffic-light" nutrition information on online food purchases in Australia. *Australian and New Zealand Journal of Public Health*, *35*(2), 122–126. https://doi.org/10.1111/j.1753-6405.2011.00684.x

Sanjari, S. S., Jahn, S., & Boztug, Y. (2017). Dual-process theory and consumer response to front-of-package nutrition label formats. *Nutrition Reviews*, *75*(11), 871–882. https://doi.org/10.1093/nutrit/nux043

Santé Publique France. (2020). *Nutri-Score*.

Santé Publique France. (2022). *CONDITIONS OF USE OF THE « NUTRI-SCORE » LOGO*.

Santos, O., Alarcão, V., Feteira-Santos, R., Fernandes, J., Virgolino, A., Sena, C., Vieira, C. P., Gregório, M. J., Nogueira, P., Graça, P., & Costa, A. (2020). Impact of different front-of-pack nutrition labels on online food choices. *Appetite*, *154*(August). https://doi.org/10.1016/j.appet.2020.104795

Savelli, E., Bravi, L., Francioni, B., Murmura, F., & Pencarelli, T. (2020). PDO labels and food preferences: results from a sensory analysis. *British Food Journal*, *123*(3). https://doi.org/10.1108/BFJ-05-2020-0435

Savelli, E., Bravi, L., Francioni, B., Murmura, F., & Pencarelli, T. (2021). PDO labels and food preferences: results from a sensory analysis. *British Food Journal*, *123*(3), 1170–1189. https://doi.org/10.1108/BFJ-05-2020-0435

Schamel, G. (2007). Auction markets for specialty food products with geographical indications. *Agricultural Economics*, *37*(2–3), 257–264. https://doi.org/10.1111/J.1574-0862.2007.00272.X

Schulz, L. L., Schroeder, T. C., & White, K. L. (2012). Value of Beef Steak Branding: Hedonic Analysis of Retail Scanner Data. *Agricultural and Resource Economics Review*, *41*(2), 260–273. https://doi.org/10.1017/S1068280500003397

Shangguan, S., Afshin, A., Shulkin, M., Ma, W., Marsden, D., Smith, J., Saheb-Kashaf, M., Shi, P., Micha, R., Imamura, F., & Mozaffarian, D. (2019). A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices. *American Journal of Preventive Medicine*, *56*(2), 300–314. https://doi.org/10.1016/j.amepre.2018.09.024

Shin, S., Puri, J., & Finkelstein, E. (2023). A randomized trial to evaluate the impact of

Singapore's forthcoming Nutri-grade front-of-pack beverage label on food and beverage purchases. *International Journal of Behavioral Nutrition and Physical Activity*, *20*(1). https://doi.org/10.1186/s12966-023-01422-4

Shogren, J. F., Shin, S. Y., Hayes, D. J., & Kliebenstein, J. B. (1994). Resolving Differences in Willingness to Pay and Willingness to Accept Jason F . Shogren , Seung Y . Shin , Dermot J . Hayes and James B . Kliebenstein Source : The American Economic Review , Vol . 84 , No . 1 (. *The American Economic Review*, *84*(1), 255–270.

Sogn-Grundvåg, G., Larsen, T. A., & Young, J. A. (2014). Product Differentiation with Credence Attributes and Private Labels: The Case of Whitefish in UK Supermarkets. *Journal of Agricultural Economics*, *65*(2), 368–382. https://doi.org/10.1111/1477-9552.12047

Stanley, L. R., & Tschirhart, J. (2012). *Hedonic Prices for a Nondurable Good : The Case of Breakfast Cereals Author (s): Linda R . Stanley and John Tschirhart Reviewed work (s): Source : The Review of Economics and Statistics , Vol . 73 , No . 3 (Aug ., 1991), pp . 537-541 Published by : . 73*(3), 537–541.

Staudigel, M., & Trubnikov, A. (2022). High price premiums as barriers to organic meat demand? A hedonic analysis considering species, cut and retail outlet*. *Australian Journal of Agricultural and Resource Economics*, *66*(2), 309–334. https://doi.org/10.1111/1467-8489.12472

Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a Measure of the Motives Underlying the Selection of Food : the Food Choice Questionnaire Department of Psychology , St George ' s Hospital Medical School , London. *Appetite*, *25*, 267–284.

Stiletto, A., Cei, L., & Trestini, S. (2023). A Little Bird Told Me. . . Nutri-Score Panoramas from a Flight over Europe, Connecting Science and Society. *Nutrients*, *15*(15), 3367.

Stiletto, A., & Trestini, S. (2022). Is it really a piece of cake to label Geographical Indications with the Nutri-Score ? Consumers ' behaviour and policy implications. *PLoS ONE*, *17*(11), 1–18. https://doi.org/10.1371/journal.pone.0277048

Storcksdieck Gennat Bonsmann, S., Marandola, G., Ciriolo, E., Van Bavel, R., & Wollgast, J. (2020). *Front-of-pack nutrition labelling schemes: a comprehensive review* (Publications Office of the European Union (ed.)). Publications Office of the European Union. https://doi.org/10.2760/436998

Sutherland, L. A., Kaely, L. A., & Fischer, L. (2010). Comment on Guiding Stars: The effect of a nutrition navigation program on consumer purchases at the supermarket. *Nutrition in Clinical Practice*, *25*(5), 560–561. https://doi.org/10.1177/0884533610379856

Szathvary, S., & Trestini, S. (2014). A Hedonic Analysis of Nutrition and Health Claims on Fruit Beverage Products. *Journal of Agricultural Economics*, *65*(2), 505–517. https://doi.org/10.1111/1477-9552.12056

Talati, Z., Norman, R., Pettigrew, S., Neal, B., Kelly, B., Dixon, H., Ball, K., Miller, C., & Shilton, T. (2017). The impact of interpretive and reductive front-of-pack labels on food choice and willingness to pay. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), 1–10. https://doi.org/10.1186/s12966-017-0628-2

Temple, N. J. (2020). Front-of-package food labels: A narrative review. *Appetite*, *144*(October 2019), 104485. https://doi.org/10.1016/j.appet.2019.104485

Ter Borg, S., Steenbergen, E., Milder, I. E. J., & Temme, E. H. M. (2021). Evaluation of nutri-score in relation to dietary guidelines and food reformulation in the Netherlands. *Nutrients*, *13*(12). https://doi.org/10.3390/nu13124536

Thøgersen, J., & Nohlen, H. U. (2022). *Consumer Understanding of Origin Labeling on Food Packaging and Its Impact on Consumer Product Evaluation and Choices: A Systematic Literature Review.*

Thorndike, E. L. (1920). A Constant Error in Psychological Ratings. *Journal of Applied Psychology*, *4*(1), 25–29. https://ci.nii.ac.jp/naid/30013652235/

Thunström, L., & Rausser, G. (2008). The marginal willingness to pay for health-related food characteristics. *Acta Agriculturae Scandinavica, Section C — Food Economics*, *5*(3–4), 194–206. https://doi.org/10.1080/16507540903064235

Török, Á., & Moir, H. V. J. . (2018). The market size for GI food products – evidence from the empirical economic literature. *Studies in Agricultural Economics*, *120*, 134–142.

Townsend, M. S. (2010). Where is the science? What will it take to show that nutrient profiling systems work? *Erican Journal of Clinical Nutrition*, *91*(4), 1109S-1115S.

Trestini, S., & Stiletto, A. (2020). Does Italian origin really determine a price premium for fluid milk? Evidences from a hedonic price analysis. *Economia Agro-Alimentare*, *22*(1), 1–22. https://doi.org/10.3280/ecag1-2020oa10064

Valenzuela, A., Zambrano, L., Velásquez, R., Groff, C., Apablaza, T., Riffo, C., Moldenhauer, S., Brisso, P., & Leonario-Rodriguez, M. (2022). Discrepancy between Food Classification Systems: Evaluation of Nutri-Score, NOVA Classification and Chilean Front-of-Package Food Warning Labels. *International Journal of Environmental Research and Public Health*, *19*(22), 14631. https://doi.org/10.3390/IJERPH192214631

Vandecandelaere, E., Samper, L. F., Rey, A., Daza, A., Mejía, P., Tartanac, F., & Vittori, M. (2021).

The geographical indication pathway to sustainability: A framework to assess and monitor the contributions of geographical indications to sustainability through a participatory process. *Sustainability (Switzerland)*, *13*(14), 1–20. https://doi.org/10.3390/su13147535

Verbeke, W. (2005). Agriculture and the food industry in the information age. *European Review of Agricultural Economics*, *32*(3), 347–368. https://doi.org/10.1093/EURRAG/JBI017

Vickrey, W. (1961). Counterspeculation, auctions, and competitive sealed tenders. *Journal of Finance*, *16*, 8–37.

Vlassopoulos, A., Katidi, A., Savvidou, T., & Kapsokefalou, M. (2022). Alignment of Nutri-Score with Mediterranean Diet Pyramid: A Food Level Analysis. *Nutrients*, *14*(23). https://doi.org/10.3390/nu14235097

Vyth, E. L., Steenhuis, I. H., Vlot, J. A., Wulp, A., Hogenes, M. G., Looije, D. H., Brug, J., & Seidell, J. C. (2010). Actual use of a front-of-pack nutrition logo in the supermarket: consumers' motives in food choice. *Public Health Nutrition*, *13*, 1882–1889. https://doi.org/10.1017/S1368980010000637

WHO. (2019). *Guiding principles and framework manual for front-of- pack labelling for promoting healthy diet*.

WHO. (2020a). *Appendix: Detailed description of additional validation studies that may be considered to select and evaluate a front-of-pack labelling scheme*.

WHO. (2020b). *World health statistics 2020: monitoring health for the SDGs, sustainable development goals.*

Withall, J., Jago, R., & Cross, J. (2009). Families' and health professionals' perceptions of influences on diet, activity and obesity in a low-income community. *Health and Place*, *15*(4), 1078–1085. https://doi.org/10.1016/j.healthplace.2009.05.006

Włodarek, D., & Dobrowolski, H. (2022). Fantastic Foods and Where to Find Them—Advantages and Disadvantages of Nutri-Score in the Search for Healthier Food. *Nutrients*, *14*(22). https://doi.org/10.3390/nu14224843

Wongprawmas, R., Mora, C., Pellegrini, N., Guiné, R. P. F., Carini, E., Sogari, G., & Vittadini, E. (2021). Food choice determinants and perceptions of a healthy diet among Italian consumers. *Foods*, *10*(2). https://doi.org/10.3390/foods10020318

World Health Organization. (2020). World health statistics 2020: monitoring health for the SDGs, sustainable development goals. In *Geneva: World Health Organization; 2020.*

Licence:

World Health Organization. (2021). *Malnutrition: Fact sheets*. https://www.who.int/news-room/fact-sheets/detail/malnutrition#:~:text=1.9 billion adults are overweight,million were overweight or obese.

Zhang, G., Wang, C. L., Liu, J., & Zhou, L. (2023). Why do consumers prefer a hometown geographical indication brand? Exploring the role of consumer identification with the brand and psychological ownership. *International Journal of Consumer Studies*, *47*(1), 74–85. https://doi.org/10.1111/ijcs.12806

Zhang, S., Sun, Y., Yu, X., & Zhang, Y. (2023). Geographical Indication, Agricultural Products Export and Urban–Rural Income Gap. *Agriculture (Switzerland)*, *13*(2), 1–16. https://doi.org/10.3390/agriculture13020378

Chapter 6

All that glitters is not gold: The impact of the Nutri-Score label on food with Geographical Indication

Abstract

The European Union is discussing the introduction of a mandatory Front-of-Pack label to contrast the increasing nutrition-related diseases. The Nutri-Score (NS) is the most supported candidate in the EU, despite some controversies are in place. Indeed, the policy behind the NS system (i.e., the Farm to Fork Strategy – F2F) seems to be at odds with the Geographical Indication (GI) one, as the same products (GIs) are promoted for their superior quality by the GI policy and frequently classified as products to be avoided by the NS system. Moreover, the NS system, by encouraging food industries to reformulate their products through the improvement of their nutritional quality, places the GIs in a disadvantageous position, due to the product specification. To explore the interactions between these two policies, this paper assesses the effect on retail prices of the presence of the NS on GI and non-GI products in the French market, being this system widely used in France. A hedonic price analysis was conducted on 254 raw hams (score D or E) through the estimation of a quantile regression model. Results highlight that the presence of the NS decreases the retail price of raw hams, limited to the high-priced segments. Interestingly, the negative effect is homogeneous for GI and non-GI hams, suggesting that the GI sign does not alleviate the impact of the NS.

Keywords: Farm to Fork; Hedonic price analysis; Front Of Pack; Retail prices; ham; Quality food products

6.1. Introduction

Nowadays, obesity is one of the main nutritional issues at the European level. In the last 20 years, the age-standardized prevalence of obesity has increased 1.5 times among adults and has more than doubled among children (World Health Organization, 2020; Ng *et al.* , 2014). To tackle this issue, the European Union (EU) is currently adopting different strategies to improve citizens' food choices and, in turn, dietary behaviors. Indeed, almost 13 out of the 17 Sustainable Development Goals (SDGs) could be linked to the obesity issue, as the SDG2, which aims to end, by 2030, all forms of malnutrition (including obesity), or the SDG3, which promotes mental health and well-being, reducing by one-third premature mortality caused by disease strictly linked with obesity, such as diabetes or cancer.

Recent literature pointed out that nutritional labelling plays a crucial role in consumer decision-making and could be a useful tool to promote healthier dietary behaviors (Fialon *et al.*, 2020). However, different authors (such as Erdem and Campbell, 2022) highlighted some issues linked to the use of nutritional labelling in guiding consumers' choice. To illustrate, due to the time constraints (Grunert et al., 2010; Sanjari et al., 2017) and to difficulties in understanding nutritional facts (Campos et al., 2011), consumers frequently ignore label information during grocery. A possible solution to overcome this issue is to use more user-friendly versions of the classical nutritional labels, namely the Front-Of-Pack (FOP) ones (Temple, 2020). These are graphic labels placed on the front of the package that give concise information about food nutritional profile. FOP information is, then, more prominently available during grocery, contributing to reduce potential information asymmetry between consumers and food manufacturers (Verbeke, 2005).

So far, in the EU, there is no single and mandatory FOP labelling: companies in the member states can choose whether and which FOP to adopt (Storcksdieck Gennat Bonsmann et al., 2020). As a consequence, the food industry can take advantage of the voluntary use of the label, endorsing the use of FOP labels only on those products for which they do not incur in a potential reduction of sales value (Carter et al., 2013; Temple, 2020). To overcome this issue, the EU, within the Farm to Fork Strategy (F2F), stressed the need to use a mandatory and homogeneous FOP label among EU member states, to reduce information asymmetry, thus improving citizens' dietary behavior. The Nutri-Score (NS), first proposed in France in 2017, is the most supported labelling at European level to fulfil this role, as it is the most efficient to classify products, within the same category, according to their nutritional quality (Ducrot *et al.*,

2015a; Ducrot *et al.*, 2015b; Julia *et al.*, 2016). Being a summary label, it provides consumers with clear and easy to understand information about the average nutritional value of the product, using together a chromatic (from green, "healthy", to dark orange, "unhealthy") and an alphabetical scale (from A, "healthy", to E, "unhealthy").

The Nutri-Score algorithm considers, per 100 grams of product, the content of nutrients and foods that should be promoted (fiber, protein, fruits and vegetables) and those that should be limited (energy, saturated fatty acids, sugars, salt) [15]. Though desirable, this system, becoming mandatory, would bring some undesirable side-effect on EU quality certification products, namely Geographical Indications (GIs). To illustrate, most of animal origin products would be scored with a negative grade (i.e., letter "D" or "E") due to their high content of calories and saturated fats per 100 g of products. Most of GIs being based on animal products, they could receive a market damage by the mandatory use of the Nutri-Score: consumers could reduce their willingness to pay for a GI product labelled with a negative NS (Stiletto & Trestini, 2022). Indeed, it is worth to noticed that in Europe about 70% of the most sold GI products are of animal origin and their sales value is, on average, twice as much as their similar non-certified counterpart (European Commission, 2021). The estimated total sales value of European GIs in 2017 was around 75 billions of euro, corresponding to 6.8% of the total EU food and drink sector. This is due to the high quality of GI products recognized on the market, which arises from specific environmental, human, and cultural characteristics, that make these unique in their kind. Besides, being the NS tailored on 100 grams portion, it does not consider that the most common "serving" quantity for these products is significantly below this threshold. Therefore, NS labelling could significantly compromise the GI sector. Furthermore, GIs must follow a strict and traditional product specification and cannot be easily reformulated to improve their Nutri-Score value, while industrial products might do, thus suffering of a binding constraint compared to conventional ones.

Despite the relevance of the topic, most of the papers on Nutri-Score have focused on outlining the power of NS to guide consumers in determining the nutritional value of food products (De Temmerman et al., 2021; Ducrot et al., 2015b, 2015a; Julia, Blanchet, et al., 2016), while very few studies aimed at shedding light on the impact of NS labelling on consumers' buying choices (Ares et al., 2018; De Bauw et al., 2021b; De Temmerman et al., 2021; Folkvord

[15]Specific regulation is available at: https://www.santepubliquefrance.fr/content/download/150258/file/Nutriscore_reglement_usage_EN_310122_VDEF.pdf.

et al., 2021; Gassler et al., 2022), especially on GI products (Stiletto & Trestini, 2022). Furthermore, the literature lacks in analyzing the effect of the Nutri-Score labelling on market sales (Ahn & Lee, 2022; Mora-García et al., 2019). To fill this gap, current study applies a Hedonic Price Model (HPM) on GI and conventional animal products in France, aiming at understanding the effect of the use of the Nutri-Score labelling on retail market prices. HPM, analyzing the variation in prices, allows to determine the market value of the products in terms of attributes' implicit prices. In perfectly competitive markets, prices are determined by the interaction of supply (which reflects production costs) and demand (which reflects consumers' preferences) (Lucas, 1975). However, assuming that the use of the NS does not lead to any additional production costs, in the current study the estimated implicit price of the NS could be interpreted as a proxy of consumers' preferences, as better discussed in the following section.

The paper is organized as follows: first, a conceptual framework of the HPM is presented; next, data and the empirical model used are illustrated. Results are reported in the third section and subsequently discussed with particular attention to potential policy implication. Final remarks are present in the last section.

6.2. Theoretical background

The hedonic price model (Rosen, 1974) rooted in Lancaster's theory of consumer demand (1966), which postulates that consumers' utility derived from buying a product is not related to the product itself, but to its attributes. It implies that products are considered as a bundle of attributes and price as a function of the implicit prices of these attributes (Rosen, 1974). Through the analysis of the variation in the price among products, it is possible to isolate the value associated to each attribute. The HPM is widely used in the agri-food sector in different fields of application and on different products, such as wine (Combris et al., 1997; Costanigro et al., 2007; Oczkowski, 1994), milk (Trestini & Stiletto, 2020), olive oil (Cavallo et al., 2018), meat (Schulz et al., 2012), seafood (Roheim et al., 2011), and fish (Sogn-Grundvåg et al., 2014). In this context, many authors have shifted the focus on health issues, estimating the implicit value of health and nutrition claims on cereals (Stanley & Tschirhart, 2012), hard bread, potato products (Thunström & Rausser, 2008), and fruit beverages (Szathvary & Trestini, 2014). However, even if a number of studies have been focusing on consumers' attitudes and stated use of FOP labels, evidences from market data is sparse (Boztuğ et al., 2015; Cawley et

al., 2015; Hamlin, 2015; Sutherland et al., 2010), especially when it comes to HPMs (Edenbrandt et al., 2018).

HPM is a widely used model, even if it has some flaws. The observed market price depends on both production costs and consumers' preferences (Lucas, 1975). Therefore, the HPM is not able to disentangle how much of the market price is due to supply or demand sides. To illustrate, additional certifications of food products, such as PDO and PGI or Organic labels, significantly affects the price of the products, as these cues are generally evaluated positively by consumers (Savelli et al., 2021) and imply higher production costs, requiring specific production processes (Iotti & Bonazzi, 2014). Conversely, when it comes to nutritional labelling, such as the NS, applying this FOP label on food products does not alter the cost structure, unless producers decide to reformulate their products to reach a better NS value. Indeed, NS calculation is based on information already present on the Back Of Pack (BOP) labels (Reg. (EU) N. 1169/2011) and thus does not require further efforts and costs to firms. It follows that, if a difference in prices exists between products with and without the NS, it could be explained by the value recognized by consumers to the FOP attribute. The estimated implicit price associated to the NS can, then, be considered as the result of the shift of the demand curve and, in a broader context, a proxy of consumers' preferences. Based on this consideration, identifying the effect of the NS on market prices allow to reveal the impact of this label on consumers' preferences.

6.3. Methodology

6.3.1. Data collection

The application of the NS being not yet mandatory within the European Union, this labelling system is not equally spread and used in all the EU countries. Within this framework, France could be considered the "motherland" of the Nutri-Score, as it largely promotes and uses this system, reflecting the health authorities' belief that NS can help reduce the obesity epidemic (Santé Publique France, 2020). For this reason, several food products available in France are labelled with NS. Moreover, France is the second European country in terms of number of certified products, following Italy, and one of the main importer of Italian PDO and PGI products (ISMEA, 2020). So, in order to estimate the effect of the NS label on food prices, especially on GI products, data was collected in France from April to June 2021.

In line with previous studies (Carlucci et al., 2014; Fedoseeva, 2020) data has been collected online, by recording prices and attributes (see section 3.2.) of all 658 hams on sale on the e-commerce websites belonging to five out the top six biggest French retailers (i.e., Auchan, Carrefour, Casino, E. Leclerc, and Intermarché, which represent the 79% of sales performed by the first nine retailers) (Journo & Snipes, 2018). All the "cooked ham" (i.e., *Jambon cuit*) and "raw ham" (*Jambon cru*) present in the websites of the supermarkets have been included in the database. To guarantee the homogeneity of products and improve the accuracy of the estimates (Caracciolo et al., 2013), any derivative or similar product, obtained with different types of meat – such as chicken and turkey – have been excluded. Indeed, using a larger sample, with heterogeneous products, the relation between prices and attributes could be biased by unobservable products features. As reported in Table 6.1, among the 658 references collected, not one of the 406 cooked hams bear a GI certification. Therefore, in the data analysis process, only raw hams have been considered (N= 252).

Table 6.1 Descriptive statistics of the sample

	Raw ham		**Cooked ham**	
	Number	**Share (in %)**	**Number**	**Share (in %)**
References collected	***252***		***406***	
Products bearing PDO certification	19	20.2	0	0
Products bearing PGI certification	75	79.8	0	0
Total	***94***	***37.3***	***0***	***0***
Products bearing "positive" NS (NS = B)	0	0.0	73	22.1
Products bearing "neutral" NS (NS = C)	0	0.0	232	70.3
Products bearing "negative" NS (NS = D)	118	70.2	25	7.6
Products bearing "very negative" NS (NS = E)	50	29.8	0	0.0
Total Products bearing NS	***168***	***66.7***	***330***	***81.3***
Products bearing GI and Negative NS (NS = D or NS = E)	***65***	***25.7***	***0***	***0.0***

6.3.2. Model specification

According to Rosen (1974), the price of a product could be interpreted as a function of its attributes. HPM allows estimating the implicit prices of product attributes, the so-called hedonic prices, through the regression of the price (y) on product characteristics (x). When the

relationship between the dependent variable and the explanatory variables vary at different percentiles of the distribution, the Quantile Regression (QR) allows to calculate a regression curve for each percentile of the dependent variable (Di Vita et al., 2015). In the specific case of NS, a QR is adopted to test whether the NS affect homogeneously products of different price quantiles (Figure 6.1).

Based on the minimization of the weighted absolute deviations, as described by Cameron & Trivedi (2005), the QR aims to estimate the conditional quantile function. The q*th* QR estimator $\widehat{\beta_a}$ minimizes over β_q the objective function (6.1)

$$Q(\beta_q) = \sum_{i:yi \geq x_i'\beta}^{N} q\left|y_i - x_i'\beta_q\right| + \sum_{i:y<x_i'\beta}^{N}(1-q)|y_i - x_i'\beta_q| \quad (6.1)$$

where 0<q<1 and β_q is used rather than β to underline that different value of q estimate different values of β. A double-log functional form has been estimated in the present study, based on the Box-Cox (1964) transformation. In the QR, that is a semi-parametric estimation, the residues are calculated through the bootstrap and due to the lack of assumptions about the error distributions, the QR is more robust to the outliers than the ordinary least square's, being virtually insensitive to heteroscedasticity.

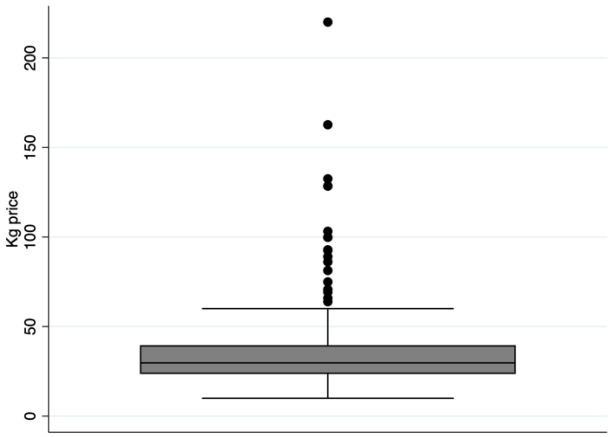

Figure 6.1. Box-plot price distribution (per kg) at different percentiles

Given the large number of product attributes (more than 50) present on the e-commerce website (brand, size, product category, nutritional claims, quality certifications and price discount), a Forward Stepwise regression has been previously performed to identify the

variables to include in the model, according to their statistical significance. The attributes considered in the QR are reported and described in Table 6.2.

Table 6.2 Descriptive statistics of the raw ham sample (variables included in the model)

Variable	Type	Mean	Std. Dev	Price level (€/kg)	
				Mean	Std. Dev
Product size (in grams)	C	116.25	4.31		
Product category					
Bulk (=1)	D	0.05	0.21	23.10	5.82
Other				36.08	24.20
Breeding technique					
*Pata Negra** (=1)	D	0.03	0.16	117.03	25.24
Other				33.14	19.27
EU Quality certification					
Parma PD= (=1)	D	0.06	0.23	44.05	13.89
Other				34.96	24.19
San Daniele PDO (=1)	D	0.02	0.14	50.15	5.05
Other				35.17	23.95
Organic (=1)	D	0.04	0.19	60.42	16.27
Other				34.54	23.56
Brand					
Private label (=1)	D	0.48	0.50	30.47	20.49
Other				40.01	25.72
Nutri-Score					
NS D or NS E *(=1)*	D	0.67	0.47	33.95	25.90
Other				38.49	18.74

Notes: D= dummy variable; C= continuous variable.
* Pata Negra label could be applied only on 100% Iberic ham, obtained from pigs fed on acorns and natural herbs.

6.4. Results

Results of the simultaneous quantile regression are reported in Table 6.3. All the variables are statistically significant at least at 10%, except for the product size for Q25, the presence of a negative NS in Q25 and Q50, and for the interaction between the presence of the Nutri-Score and the presence of the PDO certification – Parma PDO or San Daniele PDO – (*NS*PDO*) for all the quantiles. As expected, *Product size* has a negative impact on prices (β_{size} ranging from -0.135 at Q25 to -0.262 at Q50): the larger the package size, the lower the price, due, very likely, to economies of scale in package and logistic costs. The same goes for the product category: bulk product has a lower impact on prices (β_{bulk} ranging from -0.453 at Q25 to -0.585 at Q50) than packed one. The breeding technique has the most important impact on retail prices, as Pata Negra breed ($\beta_{Pata\ Negra}$ ranging from 1.207 at Q25 to 1.416 at Q75) has a

premium price, estimated following Kennedy(1981), equal to (+) 229.4% at Q25 and to (+) 305.1% at Q75. In the same vein, quality certifications have a positive impact on product prices.

Specifically, Parma PDO certification (β_{Parma} ranging from 0.338 at Q75 to 0.380 at Q25) has a premium price equal to (+) 48.5% at Q75 and to (+) 105.6% at Q25; San Daniele PDO ($\beta_{Daniele}$ ranging from 0.398 at Q75 to 0.725 at Q75) equal to (+) 48.5% at Q25 and to (+) 105.6% at Q75, and Organic label ($\beta_{Organic}$ ranging from 0.589 at Q75 to 0.775 at Q25) equal to (+) 78.4% at Q75 and to (+) 114.7% at Q25. On the contrary, the private label ($\beta_{private\_label}$ ranging from -0.241 at Q75 to -0.312 at Q75) decreases in prices by (-) 27.1% at Q25 and to (-)21.5% at Q75. When it comes to the effect of the Nutri-Score ($\beta_{NS\_D\ or\ NS\_E}$ ranging from -0.047 at Q25 to -0.129 at Q75), which is the core of the current study, it emerged that a raw ham labelled with NS (NS = D or NS = E) generates a decrease in prices only for medium- and high-prices products, equal to (-) 12.2% for the high priced ones and to (-) 12.9% for the medium-priced products. It should be stressed that raw hams could have only a negative score, as reported in Table 1. Thus, the Nutri-Score has a negative impact on prices. Besides, the interaction between the NS and the GI is not significant for any of the quartiles. It should be noted that this interaction term reflects the joint effect of the presence of the NS label and of the PDO label (either Parma PDO or San Daniele PDO). This underlines that the presence of the quality certification (PDO) is not able to "protect" the product from the negative impact of the NS.

Table 6.3 Results of Quantile regression

Variable	**Q25**			**Q50**			**Q75**		
	β (Std. Err)	**p-value**	**Premium price**	**β (Std. Err)**	**p-value**	**Premium price**	**β (Std. Err)**	**p-value**	**Premium price**
Product size (in grams)	-0.135 (0.074)	*		-0.262 (0.077)	***		-0.260 (0.103)	**	
Product category									
Bulk	-0.453 (0.128)	***	-36.9%	-0.585 (0.133)	***	-44.8%	-0.485 (0.162)	***	-39.2%
Breeding technique									
Pata Negra	1.207 (0.174)	***	229.4%	1.284 (0.242)	***	250.6%	1.416 (0.187)	***	305.1%
Quality certification									
PDO									
Parma PDO	0.380 (0.097)	***	45.6%	0.342 (0.155)	**	39.0%	0.338 (0.137)	**	38.9%
San Daniele PDO	0.725 (0.096)	***	105.6%	0.528 (0.071)	***	69.2%	0.398 (0.073)	***	48.5%
Organic	0.775 (0.144)	***	114.7%	0.632 (0.150)	***	86.1%	0.589 (0.142)	***	78.4%
Brand									
Private label	-0.312 (0.092)	***	-27.1%	-0.247 (0.057)	***	-22.0%	-0.241 (0.040)	***	-21.5%
Nutri-Score									
NS D or NS E	-0.047 (0.118)	n.s.	-5.2%	-0.136 (0.070)	*	-12.9%	-0.129 (0.044)	***	-12.2%

*NS*PDO*	0.049 (0.113)	n.s.	4.3%	0.028 (0.046)	n.s.	2.7%	0.037 (0.036)	n.s.	3.7%
Cons	3.969 (0.365)	***		4.808 (0.377)	***		4.912 (0.492)	***	
Pseudo-R^2	0.31			0.35			0.44		

***Note**: asterisks denote the levels of significance: * for p-value <0.10, ** for p-value <0.05, and *** for p-value <0.01*

The graphical representation of the coefficients, reported in Figure 6.2, underlines the variability of implicit prices at different percentiles of price. Even though the variability is generally low, these figures allow to catch the trend of the Nutri-Score estimated coefficients at different price levels. Contrary to what was assumed, it emerged that the presence of the NS has a greater impact on high-priced products, as coefficient is statistically different from zero at 5% only at Q75. In the higher quantiles (Q50 and Q75), the point estimates (and reported in Figure 2) suggests that the application of the NS on food packages is associated with a decrease in price that is around (-) 12-13%. The dependent variable being in logs, coefficients of the dummy variables can be interpreted as semi-elasticities. On the contrary, the interaction effect between the PDO and the NS is not significant in all the percentiles of the prices.

Along with the information derived from the NS coefficient, Figure 2 gives some interesting insights also on the distribution of the other explanatory variables. To illustrate, among the different quality certifications, it emerged that San Daniele PDO has a different effect depending on prices. Specifically, the presence of the PDO generates an increase in prices three times higher for the low-priced products than for the high-priced ones. On the contrary, the effect of the Parma PDO and the Organic certification is similar among all the percentiles and is well described by the average effect expressed in the Q50. The same goes for the product category, the breeding technique, and the private label.

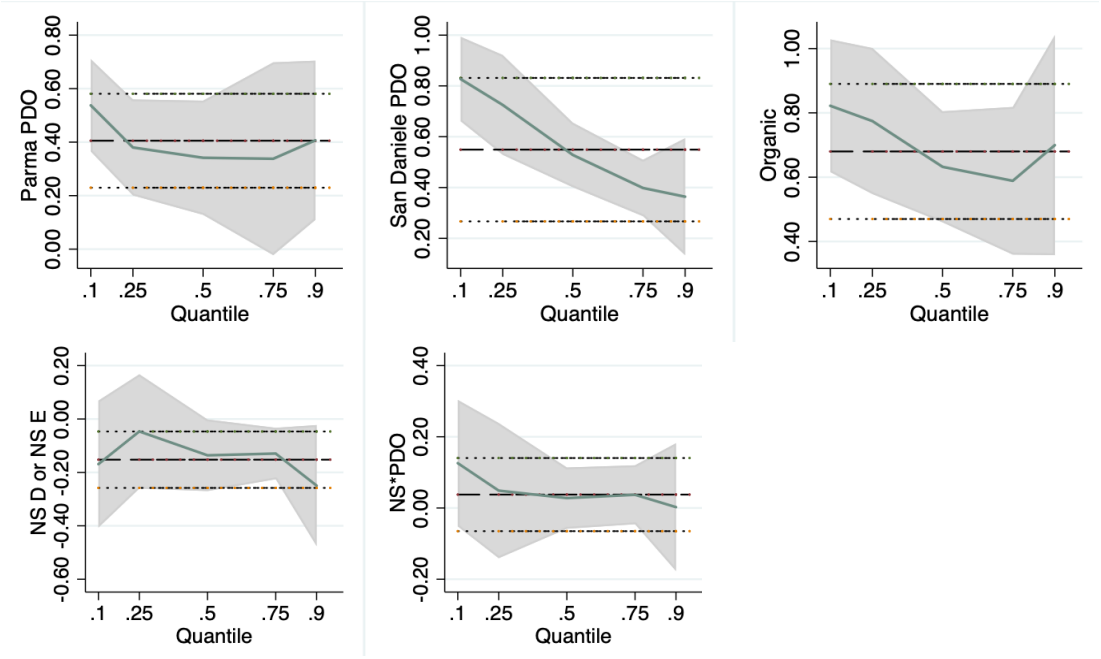

Figure 6.2. Estimated coefficients of the quantile regression and confidence interval (95%) explanatory variables

6.5. Discussion

Unsurprisingly, quality certification variables are statistically significant in determining the attribute premium in price (Parma PDO, ranging from + 38.9% to +45.6%; San Daniele PDO, from + 48.5% to +105.0%; Organic, from +78.4% to + 114.7%). As widely stressed by many authors (Resano-Ezcaray et al., 2010; Resano-Ezcaray & Sanjuàn-Lòpez, 2008; Savelli et al., 2020), PDO (and PGI) labels significantly affect food sales (and therefore the equilibrium price), being one of the key attributes in buying choices. As found by Savelli et al. (2020), these product cues have such a role in determining consumers' preferences that the presence of the PDO (or PGI) labels can even improve consumers' sensory perception towards these products. Staudigel & Trubnikov (2022) found similar results for the Organic cue, stressing the price premium attached to this attribute for both red and white meat. On the supply side, PDO and PGI products are characterised by specificity in the production methods that increase production costs and therefore retail prices. Among the quality attributes analyzed in the model, Figure 2 clearly shows a slight variability (even if it is the largest compared to the other labels) in the distribution of the "San Daniele PDO" coefficient among percentile: the lower the price, the greater the positive effect of the Denomination.

The same goes for the "Pata Negra" attribute, which has the highest impact on the price (+ 305.1% at Q75). Only hams "100% Iberico" produced by pork fed with corns could bear the Pata Negra label (Real Decreto 4/2014[16]). This breeding technique entails higher production costs compared to the base product, which is reflected in the higher price of the final product. Besides, we can argue that this product may benefit from higher preferences from the demand side, but no evidence has been highlighted by previous research, to the best of our knowledge. When it comes to the product category, results stressed a decrease in prices for bulk products with respect to the packaged ones (ranging from -36.9% to – 44.8%), due to the economies of scale (Schamel, 2007) and the lower costs for the reduced amount of services attached. The same goes for the Private labels (from -21.5% to -27.1%), notoriously cheaper than brandied products (Bronnmann & Hoffmann, 2018).

Regarding the core of the research, namely the Nutri-Score, results underline a decrease in prices for the products bearing a Nutri-Score label. Conversely, recent scholars (see for instance De Temmerman et al., 2021) argue that the presence of the NS significantly affect consumers' purchasing intention for healthy products, thus increasing them, but does not alter consumers' buying choices for unhealthy products. However, what found by De Temmerman et al. (2021), albeit in a hypothetical context, is somewhat implausible due to the demand saturation for food consumption. If sales of healthy products increase while those of unhealthy products remain unchanged, this means that there will be a general increase in consumption and not just a change in it, as it is often the case (Cirera & Masset, 2010).

Furthermore, it should be stressed that raw hams could be only scored negatively (D and E) according to the NS algorithm, as reported in Table 1. Therefore, results well describe what would happen in the market if the NS would be introduced on a mandatory basis within the EU. Since the implicit price of the NS could be considered as the expression of the effect of the solely consumers' preferences – and not of the supply side ones, as widely discussed in a previous paragraph – the estimated coefficient for NS variable is the result of the leftward shift of the demand curve. It can be, then, inferred that consumers are less likely to buy or less willing to pay for products with negative NS, in line with what found by Egnell et al. (2018) and by Julia et al. (2017), based on stated preferences. At first glance, the negative effect of the NS on certain product categories (including raw hams) might seem to be in line with the objectives set by the

[16] https://www.boe.es/diario_boe/txt.php?id=BOE-A-2014-318

European Commission, in view of reducing the consumption of the products rich in saturated fat and calories. However, QR estimates suggest that, for low price raw hams, the NS is ineffective on demand side and therefore on preferences of consumers of such products and only high price hams suffer the negative effect of the NS. This suggests that consumers with budgetary constraints that buy low price goods do not care about NS. This may yield to the opposite of the desired results, considering that obesity seems to be most pronounced in economically disadvantaged groups (Withall et al., 2009).

6.6. Policy implication

Results of the QR clearly suggest that the presence of the NS has a significant effect on the price only for products with a high price, meaning that the NS does not have a homogeneous effect on all the products analyzed, with potential market biases. As reported in Table 2 and in Table 3, the most expensive products are generally those with some Quality certification, such as the Protected Designation of Origin or the Organic labels. It follows that EU Quality products could be the most damaged by the adoption of this FOP labelling, as suggested by Stiletto & Trestini (2022): consumers are generally willing to pay less for PDO products bearing a negative NS. Hence, in sight of introducing the NS at the European level, such as other similar labels, consumers will continue to buy products with Designations of Origin only if they are cheaper. Put differently, these products, protected by the EU because of higher quality (Reg 1151/2011), will be to some extent devalued. This is strengths by the fact that the PDO logo does not have an halo effect (Thorndike, 1920) on the general evaluation of the products, as the interaction between PDO and NS is not statistically significant in the QR, in line with recent findings (Stiletto & Trestini, 2022). In broad terms, it can be assumed that the European Union is promoting two contrasting policies at the same time: the F2F (at least within the social dimension of sustainability, related to the nutritional aspects), which bolster the NS adoption at European level, and the EU GI policy, which supports the PDO and PGI products for their quality. Even if the two policies focus on different aspects, as the F2F strategy, through the adoption of the NS, supports the most nutritionally sound products, and the GI policy promotes the quality of the protected products for their link with the territory and their traditional know-how, the effect is nevertheless contrasting. Indeed, PDO products are praised on the one hand (GI policy) and condemned on the other (F2F), creating confusion among consumers and underlining the risk of a paradox in the EU legislation proposal. Moreover, F2F strategy,

targeting all the dimensions of sustainability, focuses also on the other aspects of social sustainability (e.g., support of local economy), coherently with GIs policy. Therefore, supporting the NS at EU level would reveal, to some extent, an internal inconsistency of F2F. Hence, the European Commission should consider these aspects.

Some proposals currently on the table concern the use of alternatives FOP labels or the exclusion of the GI products from the mandatory NS system. However, excluding only GIs from this labeling system could still result in an undesirable effect, as consumers, not seeing the NS, might be confused and suspicious of GI products value. Alternatively, some improvement could be implemented to the Nutri-Score profiling system, considering the actual package size, especially for the ready to eat products, or estimating the nutritional score on the serving size, namely the consumption intake recommended by nutritionists considering the daily reference intake. In this way, some PDO products (such as Prosciutto di Parma PDO or Parmigiano Reggiano PDO), which are generally consumed in much smaller quantities than 100g (the recommended dose is equal to 50g for Prosciutto di Parma PDO and 20g for Parmigiano Reggiano PDO), might not be penalized.

Against this framework, nutrition education campaigns should be promoted and supported along with the use of the FOP label, not only to educate consumers to follow a healthier and more balanced diet, but also to drive consumers in the right interpretation of the NS label. Saying that the “overall nutritional value” of a product is “not good” is completely different from saying that that product should be "consumed in moderation" (Hercberg et al., 2021). Likely, the first wording leads consumers to deem that a product with NS equal to D or E should be always avoided, due to its low quality. The second, on the other hand, helps them to understand to what extent they must consume that specific product to follow a balanced diet. Therefore, a clear way of interpreting the Nutri-Score label should be defined and provided to consumers, especially in the period following its mandatory introduction, considering that consumers in different countries have different levels of familiarity with the label, a key-factor in the objective understanding of the labels (Santos et al., 2020).

6.6.Conclusions

Current paper aims at shedding light on the price premium generated on animal products by different attributes, with particular attention to the GI products. More in-depth, this study aims to understand the effect of the application of the Nutri-Score labelling on retail

market prices through the estimation of a Hedonic Price model. Results suggest that, despite GI certifications benefit of the highest premium price, the presence of a negative NS implies a negative effect on both GI and conventional products. Against this framework, it should be stressed that the implicit price of the Nutri-Score could be interpreted as the solely effect of consumers' preferences, as adding the NS on a food product does not imply any additional cost for producers if they do not reformulate their products. Therefore, the decrease in prices emerged in the study could be interpreted as the result of the solely reduction of consumer utility for a negative NS-labelled product. However, results underline that the NS negatively and significantly affect the price only for high-priced products, which likely are those bearing some quality certification, such as PDO or Organic products. It follows that the NS implementation at EU level could damage most of GI products: consumers are willing to pay GI products less and/or consume them less. Furthermore, our results highlighted another chink in the F2F strategy: penalizing only the high-priced products, the NS system is more likely to be ineffective for "price-driven" consumers, which are, in general, considered the target of policies against malnutrition and diet-related issues. Further studies are therefore needed to assess more in depth the efficiency and effectiveness of the NS system on the diet consumption habits of the EU citizens, as well as to estimate the economic drop caused by the NS policy on GI products.

References

Adriouch, S., Julia, C., Kesse-Guyot, E., Ducrot, P., Péneau, S., Méjean, C., Assmann, K. E., Deschasaux, M., Hercberg, S., Touvier, M., & Fezeu, L. K. (2017). Association between a dietary quality index based on the food standard agency nutrient profiling system and cardiovascular disease risk among French adults. *International Journal of Cardiology*, *234*, 22–27. https://doi.org/10.1016/j.ijcard.2017.02.092

Ahn, C., & Lee, C. G. (2022). Effect of NUTRI-SCORE labeling on sales of food items in stores at sports and non-sports facilities. *Preventive Medicine Reports*, *29*(February), 101919. https://doi.org/10.1016/j.pmedr.2022.101919

Altamore, L., Ingrassia, M., Columba, P., Chironi, S., & Bacarella, S. (2020). Italian Consumers' Preferences for Pasta and Consumption Trends: Tradition or Innovation? *Journal of International Food and Agribusiness Marketing*, *32*(4), 337–360. https://doi.org/10.1080/08974438.2019.1650865

Ares, G., Varela, F., Machin, L., Antúnez, L., Giménez, A., Curutchet, M. R., & Aschemann-Witzel, J. (2018). Comparative performance of three interpretative front-of-pack nutrition labelling schemes: Insights for policy making. *Food Quality and Preference*, *68*, 215–225. https://doi.org/10.1016/J.FOODQUAL.2018.03.007

Arfini, F. (1999). The value of typical products: the case of Prosciutto di Parma and Parmigiano Reggiano cheese. *The Socio-Economics of Origin Labelled Products: Spatial, Institutional and Co-Ordination Aspects*, 78–97. http://ageconsearch.umn.edu/record/241032/files/Arfini _1999_ The value of typical products.pdf

Arfini, F., Boccaletti, S., Giacomini, C., Moro, D., & Sckokai, P. (2006). Case studies: Parmigiano Reggiano. *DG JRC/IPTS*.

Ballarini, G. (2022). Italiani consumatori di formaggio. *Ruminantia*.

Becker, G. M., DeGroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Experiments in Environmental Economics*, *9*(1964), 226–232.

Benfatto, L. (2021). Piadina protagonista sulla tavola: crescita record per le aziende del settore. *Ilsole24ore*.

Bilal, M., & Oxentenko, A. S. (2020). The Impact of Twitter: Why Should You Get Involved, and Tips and Tricks to Get Started. *American Journal of Gastroenterology*, *115*(10), 1549–1552. https://doi.org/10.14309/ajg.0000000000000763

Blasco, M. M., & Jiménez-Morales, M. (2021). Breakfast food advertising and prevention of

obesity: Analysis of the nutritional value of the products and discursive strategies used in the breakfast ads from 2015 to 2019. *Nutrients*, *13*(1), 1–9. https://doi.org/10.3390/nu13010231

Borgmeier, I., & Westenhoefer, J. (2009). *Impact of different food label formats on healthiness evaluation and food choice of consumers: a randomized-controlled study*. https://doi.org/10.1186/1471-2458-9-184

Bostic, S. M., & McClain, A. C. (2017). Older adults' cooking trajectories: shifting skills and strategies. *British Food Journal*, *119*(5), 1102–1115. https://doi.org/10.1108/BFJ-09-2016-0436

Boztuğ, Y., Juhl, H. J., Elshiewy, O., & Jensen, M. B. (2015). Consumer response to monochrome Guideline Daily Amount nutrition labels. *Food Policy*, *53*, 1–8. https://doi.org/10.1016/j.foodpol.2015.03.002

Braesco, V., Ros, E., Govindji, A., Bianchi, C., Becqueriaux, L., & Quick, B. (2022). A Slight Adjustment of the Nutri-Score Nutrient Profiling System Could Help to Better Reflect the European Dietary Guidelines Regarding Nuts. *Nutrients*, *14*(13). https://doi.org/10.3390/nu14132668

Braveman, P. A., Cubbin, C., Egerter, S., Chideya, S., Marchi, K. S., Metzler, M., & Posner, S. (2005). Socioeconomic Status in Health Research. *Jama*, *294*(22), 2879. https://doi.org/10.1001/jama.294.22.2879

Bronnmann, J., & Hoffmann, J. (2018). Product differentiation in the German soft drink market: which attributes matter? *Applied Economics Letters*, *25*(14), 968–971. https://doi.org/10.1080/13504851.2017.1388906

Cameron, A., & Trivedi, P. (2005). *Microeconometrics: Methods and Applications*. https://doi.org/10.1017/CBO9780511811241

Campos, S., Doxey, J., & Hammond, D. (2011). Nutrition labels on pre-packaged foods: A systematic review. In *Public Health Nutrition* (Vol. 14, Issue 8, pp. 1496–1506). https://doi.org/10.1017/S1368980010003290

Capacci, S., Mazzocchi, M., Shankar, B., Macias, B., Verbeke, W., Ja Pérez-Cueto, F., Kozioł-Kozakowska, A., Piórecka, B., Niedzwiedzka, B., D'addesa, D., Saba, A., Turrini, A., Aschemann-Witzel, J., Bech-Larsen, T., Strand, M., Smillie, L., Wills, J., & Traill, B. (2012). Policies to promote healthy eating in Europe: a structured review of policies and their effectiveness. *Nutrition Reviews*, *70*(3), 188–200. https://doi.org/10.1111/j.1753-4887.2011.00442.x

Caracciolo, F., Cembalo, L., & Pomarici, E. (2013). The hedonic price for an Italian grape variety. *Italian Journal of Food Science*, *25*(3). https://flore.unifi.it/retrieve/handle/2158/820872/26648/IJFS253.rar#page=42

Carlucci, D., De Gennaro, B., Roselli, L., & Seccia, A. (2014). E-commerce retail of extra virgin olive oil: An hedonic analysis of Italian Smes supply. *British Food Journal*, *116*(10), 1600–1617. https://doi.org/10.1108/BFJ-05-2013-0138

Carruba, M. O., Caretto, A., De Lorenzo, A., Fatati, G., Ghiselli, A., Lucchin, L., Maffeis, C., Malavazos, A., Malfi, G., Riva, E., Ruocco, C., Santini, F., Silano, M., Valerio, A., Vania, A., & Nisoli, E. (2022). *Front-of-pack (FOP) labelling systems to improve the quality of nutrition information to prevent obesity: NutrInform Battery vs Nutri-Score*. *27*, 1575–1584. https://doi.org/10.1007/s40519-021-01316-z

Carter, O., Mills, B. W., Lloyd, E., & Phan, T. (2013). An independent audit of the Australian food industry's voluntary front-of-pack nutrition labelling scheme for energy-dense nutrition-poor foods. *European Journal of Clinical Nutrition*, *67*, 31–35. https://doi.org/10.1038/ejcn.2012.179

Caso, G., & Vecchio, R. (2022). Factors influencing independent older adults (un)healthy food choices: A systematic review and research agenda. *Food Research International*, *158*(February), 111476. https://doi.org/10.1016/j.foodres.2022.111476

Cavallo, C., Caracciolo, F., Cicia, G., & Del Giudice, T. (2018). Extra-virgin olive oil: are consumers provided with the sensory quality they want? A hedonic price model with sensory attributes. *Journal of the Science of Food and Agriculture*, *98*(4), 1591–1598. https://doi.org/10.1002/JSFA.8633

Cawley, J., Sweeney, M. J., Sobal, J., Just, D. R., Kaiser, H. M., Schulze, W. D., Wethington, E., & Wansink, B. (2015). The impact of a supermarket nutrition rating system on purchases of nutritious and less nutritious foods. *Public Health Nutrition*, *18*(1), 8–14. https://doi.org/10.1017/S1368980014001529

Cei, L., Defrancesco, E., & Stefani, G. (2018). From geographical indications to rural development: A review of the economic effects of European Union policy. *Sustainability (Switzerland)*, *10*(10). https://doi.org/10.3390/su10103745

Chang, J. B., Lusk, J. L., & Norwood, B. F. (2009). How closely do hypothetical surveys and laboratory experiments predict field behavior? *American Journal of Agricultural Economics*, *91*(2), 518–534. https://doi.org/10.1111/j.1467-8276.2008.01242.x

Chantal, J., Touvier, M., Kesse-Guyot, E., Galan, P., & Hercberg, S. (2022). Nutri-Score in tug-of-

war between public health and economic interests in the European Union. *Nature Food*, *3*(181).

Cirera, X., & Masset, E. (2010). Income distribution trends and future food demand. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2821–2834. https://doi.org/10.1098/rstb.2010.0164

Combris, P., Lecocq, S., & Visser, M. (1997). Estimation of a Hedonic Price Equation for Bordeaux Wine: Does Quality Matter? *The Economic Journal*, *107*(441), 390–402. https://doi.org/10.1111/j.0013-0133.1997.165.x

Commission, E. (2021). *Study on economic value of EU quality schemes, geographical indications (GIs) and traditional specialities guaranteed (TSGs) : final report*. Publications Office. https://doi.org/doi/10.2762/396490

Costanigro, M., McCluskey, J. J., & Mittelhammer, R. C. (2007). Segmenting the Wine Market Based on Price: Hedonic Regression when Different Prices mean Different Products. *Journal of Agricultural Economics*, *58*(3), 454–466. https://doi.org/10.1111/j.1477-9552.2007.00118.x

Cowburn, G., & Stockley, L. (2005). Consumer understanding and use of nutrition labelling: a systematic review. *Public Health Nutrition*, *8*(1), 21–28. https://doi.org/10.1079/phn2005666

Cozzi, E., Donati, M., Mancini, M. C., Guareschi, M., & Veneziani, M. (2019). PDO parmigiano reggiano cheese in Italy. *Sustainability of European Food Quality Schemes: Multi-Performance, Structure, and Governance of PDO, PGI, and Organic Agri-Food Systems*, 427–449. https://doi.org/10.1007/978-3-030-27508-2_22

Crescenzi, R., De Filippis, F., Giua, M., & Vaquero-Piñeiro, C. (2022). Geographical Indications and local development: the strength of territorial embeddedness. *Regional Studies*, *56*(3), 381–393. https://doi.org/10.1080/00343404.2021.1946499

Crosetto, P., Lacroix, A., Muller, L., & Ruffieux, B. (2017). Modifications of food purchases in response to five nutrition simplified labelling. *Cahiers de Nutrition et de Dietetique*, *52*(3), 129–133. https://doi.org/10.1016/j.cnd.2017.04.002

Darby, M. R., & Karni, E. (1973). Free competition and the optimal amount of fraud. *The Journal of Law and Economics*, *16*(1), 67–88.

Darmon, N., & Drewnowski, A. (2008). Does social class predict diet quality? *American Journal of Clinical Nutrition*, *87*(5), 1107–1117. https://doi.org/10.1093/ajcn/87.5.1107

De Bauw, M., De La Revilla, L. S., Poppe, V., Matthys, C., & Vranken, L. (2022). Digital nudges to

stimulate healthy and pro-environmental food choices in E-groceries. *Appetite*, *172*(July 2021), 105971. https://doi.org/10.1016/j.appet.2022.105971

De Bauw, M., Matthys, C., Poppe, V., Franssens, S., & Vranken, L. (2021a). A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. *Food Quality and Preference*, *93*(April), 104276. https://doi.org/10.1016/j.foodqual.2021.104276

De Bauw, M., Matthys, C., Poppe, V., Franssens, S., & Vranken, L. (2021b). A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. *Food Quality and Preference*, *93*, 104276. https://doi.org/10.1016/J.FOODQUAL.2021.104276

De Temmerman, J., Heeremans, E., Slabbinck, H., & Vermeir, I. (2021). The impact of the Nutri-Score nutrition label on perceived healthiness and purchase intentions. *Appetite*, *157*, 104995. https://doi.org/10.1016/J.APPET.2020.104995

Delamaire, C., Bossard, C., & Julia, C. (2008). Perceptions, connaissances et attitudes en matière d'alimentation. In *Baromètre santé nutrition 2008* (pp. 80–116).

Delhaize. (2022). *Producten met een verbeterde Nutri-Score*. https://www.delhaize.be/nl/nutriscore-update, accessed 28 July 2022

Deschamps, V., Julia, C., Salanave, B., Verdot, C., Hercberg, S., & Castetbon, K. (2015). Score de qualité nutritionnelle des aliments dela Food Standards Agency appliqué aux consommationsalimentaires individuelles des adultes en France. *Bulletin Epidémiologique Hebdomadaire*, 466–475.

Deschasaux, M., Julia, C., Kesse-Guyot, E., Lécuyer, L., Adriouch, S., Méjean, C., Ducrot, P., Péneau, S., Latino-Martel, P., Fezeu, L. K., Fassier, P., Hercberg, S., & Touvier, M. (2017). Are self-reported unhealthy food choices associated with an increased risk of breast cancer? Prospective cohort study using the British Food Standards Agency nutrient profiling system. *BMJ Open*, *7*(6). https://doi.org/10.1136/bmjopen-2016-013718

Deselnicu, O. C., Costanigro, M., Souza-Monteiro, D. M., & McFadden, D. T. (2013). A Meta-Analysis of Geographical Indication Food Valuation Studies: What Drives the Premium for Origin-Based Labels? *Journal of Agricultural and Resource Economics*, *2*, 204–219.

Di Vita, G., Caracciolo, F., Cembalo, L., Pomarici, E., & D'Amico, M. (2015). Drinking wine at home: Hedonic analysis of sicilian wines using quantile regression. *American Journal of Applied Sciences*, *12*(10), 679–688. https://doi.org/10.3844/ajassp.2015.679.688

Djuricic, I., & Calder, P. C. (2021). Beneficial outcomes of omega-6 and omega-3

polyunsaturated fatty acids on human health: An update for 2021. *Nutrients*, *13*(7). https://doi.org/10.3390/nu13072421

Dobbs, R., & Manyika, J. (2015). The Obesity Crisis. *The Cairo Review of Global Affairs*, 44–57. https://doi.org/10.1159/000355993

Dowler, E. (2001). Inequalities in diet and physical activity in Europe. *Public Health Nutrition*, *4*(2b), 701–709. https://doi.org/10.1079/phn2001160

Dréano-Trécant, L., Egnell, M., Hercberg, S., Galan, P., Soudon, J., Fialon, M., Touvier, M., Kesse-Guyot, E., & Julia, C. (2020). Performance of the front-of-pack nutrition label nutri-score to discriminate the nutritional quality of foods products: A comparative study across 8 european countries. *Nutrients*, *12*(5). https://doi.org/10.3390/nu12051303

Dubois, P., Albuquerque, P., Allais, O., Bonnet, C., Bertail, P., Combris, P., Lahlou, S., Rigal, N., Ruffieux, B., & Chandon, P. (2020). Effects of front-of-pack labels on the nutritional quality of supermarket food purchases: evidence from a large-scale randomized controlled trial. *Journal of the Academy of Marketing Science*. https://doi.org/10.1007/s11747-020-00723-5

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L., Hercberg, S., & Péneau, S. (2015a). Effectiveness of Front-Of-Pack Nutrition Labels in French Adults: Results from the NutriNet-Santé Cohort Study. *PLoS One, 10*(10). https://doi.org/10.1371/journal.pone.0140898

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L. K., Hercberg, S., & Péneau, S. (2015b). Objective Understanding of Front-of-Package Nutrition Labels among Nutritionally At-Risk Individuals. *Nutrients*, *7*, 7106–7125. https://doi.org/10.3390/nu7085325

Edenbrandt, A. K., Smed, S., & Jansen, L. (2018). A hedonic analysis of nutrition labels across product types and countries. *European Review of Agricultural Economics*, *45*(1), 101–120. https://doi.org/10.1093/erae/jbx025

Egnell, M., Ducrot, P., Touvier, M., Allès, B., Hercberg, S., Kesse-Guyot, E., & Julia, C. (2018). Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: Comparisons with other format labels. *PLoS ONE*, *13*(8). https://doi.org/10.1371/journal.pone.0202095

Egnell, M., Galan, P., Fialon, M., Touvier, M., Péneau, S., Kesse-Guyot, E., Hercberg, S., & Julia, C. (2021). The impact of the Nutri-Score front-of-pack nutrition label on purchasing intentions of unprocessed and processed foods: post-hoc analyses from three

randomized controlled trials. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 1–12. https://doi.org/10.1186/s12966-021-01108-9

Elizabeth, L., Machado, P., Zinöcker, M., Baker, P., & Lawrence, M. (2020). Ultra-processed food and adverse health outcomes. *Nutrients*, *12*(7). https://doi.org/10.1136/bmj.l2289

European Commission. (2020a). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system*.

European Commission. (2020b). *Geographical Indications - a Europeam tresure worth €75 billion*.

FAO. (2021). *The Nutrition and Health Potential of Geographical Indication Foods*.

Fedoseeva, S. (2020). (Dynamic) willingness to pay and e-commerce: Insights from sparkling wine sector in Russia. *Journal of Retailing and Consumer Services*, *57*, 102180. https://doi.org/10.1016/J.JRETCONSER.2020.102180

Fialon, M, Salas-Salvadó, J., Babio, N., Touvier, M., Hercberg, S., & Galan, P. (2021). Is fop nutrition label nutri-score well understood by consumers when comparing the nutritional quality of added fats, and does it negatively impact the image of olive oil? *Foods*, *10*(9). https://doi.org/10.3390/foods10092209

Fialon, Morgane, Egnell, M., Talati, Z., Galan, P., Dréano-Trécant, L., Touvier, M., Pettigrew, S., Hercberg, S., & Julia, C. (2020). Effectiveness of different front-of-pack nutrition labels among italian consumers: Results from an online randomized controlled trial. *Nutrients*, *12*(8), 1–13. https://doi.org/10.3390/nu12082307

Fialon, Morgane, Serafini, M., Galan, P., Kesse-Guyot, E., Touvier, M., Deschasaux-Tanguy, M., Sarda, B., Hercberg, S., Nabec, L., & Julia, C. (2022). Nutri-Score and NutrInform Battery: Effects on Performance and Preference in Italian Consumers. *Nutrients*, *14*(17), 1–12. https://doi.org/10.3390/nu14173511

Folkvord, F., Bergmans, N., & Pabian, S. (2021). The effect of the nutri-score label on consumer's attitudes, taste perception and purchase intention: An experimental pilot study. *Food Quality and Preference*, *94*, 104303. https://doi.org/10.1016/j.foodqual.2021.104303

Forner, F., Volkhardt, I., Meier, T., Christen, O., & Stangl, G. I. (2021). The nutriRECIPE-Index – development and validation of a nutrient-weighted index for the evaluation of recipes. *BMC Nutrition*, *7*(1). https://doi.org/10.1186/s40795-021-00483-7

Fuchs, K. L., Lian, J., Michels, L., Mayer, S., Toniato, E., & Tiefenbeck, V. (2022). Effects of Digital Food Labels on Healthy Food Choices in Online Grocery Shopping. *Nutrients*, *14*(10), 2044. http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=84403754&site=ehost-live

Gassler, B., Faesel, C. K., & Moeser, A. (2022). Toward a differentiated understanding of the effect of Nutri-Score nutrition labeling on healthier food choices. *Agribusiness*, *39*(1), 28–50. https://doi.org/10.1002/AGR.21762

Glogoveţan, A. I., Dabija, D. C., Fiore, M., & Pocol, C. B. (2022). Consumer Perception and Understanding of European Union Quality Schemes: A Systematic Literature Review. *Sustainability (Switzerland)*, *14*(3), 1–16. https://doi.org/10.3390/su14031667

Graham, D. J., Lucas-Thompson, R. G., Mueller, M. P., Jaeb, M., & Harnack, L. (2017). Impact of explained v. unexplained front-of-package nutrition labels on parent and child food choices: A randomized trial. *Public Health Nutrition*, *20*(5), 774–785. https://doi.org/10.1017/S1368980016002676

Grunert, K. G., & Aachmann, K. (2016). Consumer reactions to the use of EU quality labels on food products: Areview of the literature. *Food Control*, *59*, 178–187. https://doi.org/10.1016/j.foodcont.2015.05.021

Grunert, K. G., Fernández-Celemín, L., Wills, J. M., Bonsmann, S. S. G., & Nureeva, L. (2010). Use and understanding of nutrition information on food labels in six European countries. *Journal of Public Health*, *18*(3), 261–277. https://doi.org/10.1007/s10389-009-0307-0

Grunert, K. G., & Wills, J. M. (2007). A review of European research on consumer response to nutrition information on food labels. *Journal of Public Health*, *15*(5), 385–399. https://doi.org/10.1007/s10389-007-0101-9

Habib, S. H., & Saha, S. (2010). Burden of non-communicable disease: Global overview. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *4*(1), 41–47. https://doi.org/10.1016/j.dsx.2008.04.005

Hafner, E., & Pravst, I. (2021). Evaluation of the Ability of Nutri-Score to Discriminate the Nutritional Quality of Prepacked Foods Using a Sale-Weighting Approach. *Foods*, *10*, 1689. https://doi.org/10.3390/foods10081689

Hall, K. D., Ayuketah, A., Brychta, R., Cai, H., Cassimatis, T., Chen, K. Y., Chung, S. T., Costa, E., Courville, A., Darcey, V., Fletcher, L. A., Forde, C. G., Gharib, A. M., Guo, J., Howard, R., Joseph, P. V., McGehee, S., Ouwerkerk, R., Raisinger, K., … Zhou, M. (2019). Ultra-

Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake. *Cell Metabolism*, *30*(1), 67-77.e3. https://doi.org/10.1016/j.cmet.2019.05.008

Hamlin, R. (2015). Front of Pack Nutrition Labelling, Nutrition, Quality and Consumer Choices. *Current Nutrition Reports*, *4*(4), 323–329. https://doi.org/10.1007/s13668-015-0147-1

Hawkes, C., & Popkin, B. M. (2015). Can the sustainable development goals reduce the burden of nutrition-related non-communicable diseases without truly addressing major food system reforms? *BMC Medicine*, *13*(1), 1–3. https://doi.org/10.1186/s12916-015-0383-7

Hercberg, S., Touvier, M., & Salas-salvado, J. (2022). The Nutri-Score nutrition label. *International Journal for Vitamin and Nutrition Research*, *92*(3–4), 147–157.

Hercberg, S., Touvier, M., & Salas-Salvado, J. (2021). The Nutri-Score nutrition label. *Https://Doi.Org/10.1024/0300-9831/A000722*, *92*(3–4), 147–157. https://doi.org/10.1024/0300-9831/A000722

Hillmann, H., & Hofmann, T. (2016). Quantitation of Key Tastants and Re-engineering the Taste of Parmesan Cheese. *Journal of Agricultural and Food Chemistry*, *64*(8), 1794–1805. https://doi.org/10.1021/acs.jafc.6b00112

Höhn, G. L., Huysmans, M., & Crombez, C. (2023). Healthy food traditions? Nutritional quality and food composition of EU geographical indications. *Q Open*, *3*(1), 1–20. https://doi.org/10.1093/qopen/qoad014

Holmes, T. P., Adamowicz, W. L., & Carlsson, F. (2017). Choice Experiments. In *A Primer on Nonmarket Valuation*.

Iotti, M., & Bonazzi, G. (2014). The application of Life Cycle Cost (LCC) approach to quality food production: A comparative analysis in the parma pdo ham sector. *American Journal of Applied Sciences*, *11*(9), 1492–1506. https://doi.org/10.3844/ajassp.2014.1492.1506

ISMEA. (2019). *Rapporto 2019 Ismea-Qualivita sulle produzioni agroalimentari e vitivinicole italiane DOP, IGP e STG*.

ISMEA. (2020). *Rapporto Ismea - Qualivita 2020*.

ISMEA. (2021). *RAPPORTO ISMEA - QUALIVITA 2021 sulle produzioni vitivinicole e agroalimentari DOP Italia*.

Jiménez-Morales, M., & Montaña Blasco, M. (2021). Presence and strategic use of the Mediterranean Diet in food marketing: Analysis and association of nutritional values and advertising claims from 2011 to 2020. *NFS Journal*, *24*(April), 1–6. https://doi.org/10.1016/j.nfs.2021.04.003

Journo, L. J., & Snipes, K. (2018). FRANCE RETAIL FOODS 2018. In *USDA Foreign Agricultural Service*.

Julia, C., Blanchet, O., Méjean, C., Péneau, S., Ducrot, P., Allès, B., Fezeu, L. K., Touvier, M., Kesse-Guyot, E., Singler, E., & Hercberg, S. (2016). Impact of the front-of-pack 5-colour nutrition label (5-CNL) on the nutritional quality of purchases: An experimental study. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1), 1–9. https://doi.org/10.1186/s12966-016-0416-4

Julia, C., Ducrot, P., Péneau, S., Deschamps, V., Méjean, C., Fézeu, L., Touvier, M., Hercberg, S., & Kesse-Guyot, E. (2015). Discriminating nutritional quality of foods using the 5-Color nutrition label in the French food market: Consistency with nutritional recommendations. *Nutrition Journal*, *14*(1), 1–12. https://doi.org/10.1186/s12937-015-0090-4

Julia, C., & Hercberg, S. (2016). Research and lobbying conflicting on the issue of a front-of-pack nutrition labelling in France. *Archives of Public Health*, *74*(1), 1–5. https://doi.org/10.1186/s13690-016-0162-8

Julia, C., & Hercberg, S. (2017a). Development of a new front-of-pack nutrition label in France: the five-colour Nutri-Score. *Public Health Panorama*, *03*(04), 712–725.

Julia, C., & Hercberg, S. (2017b). Nutri-Score: evidence of the effective-ness of the French front-of-pack nutrition label. *Ernahrungs Umschau*, *64*(12), 181–187. https://doi.org/10.4455/eu.2017.048

Julia, C., Méjean, C., Touvier, M., Péneau, S., Lassale, C., Ducrot, P., Hercberg, S., & Kesse-Guyot, E. (2016). Validation of the FSA nutrient profiling system dietary index in French adults—findings from SUVIMAX study. *European Journal of Nutrition*, *55*(5), 1901–1910. https://doi.org/10.1007/s00394-015-1006-y

Julia, C., Péneau, S., Buscail, C., Gonzalez, R., Touvier, M., Hercberg, S., & Kesse-Guyot, E. (2017). Perception of different formats of front-of-pack nutrition labels according to sociodemographic, lifestyle and dietary factors in a French population: Cross-sectional study among the NutriNet-Santé cohort participants. *BMJ Open*, *7*(6). https://doi.org/10.1136/bmjopen-2017-016108

Katsouri, E., Magriplis, E., Zampelas, A., Drosinos, E. H., & Nychas, G.-J. (2021). Dietary intake assessment of pre-packed graviera cheese in greece and nutritional characterization using the nutri-score front of pack label scheme. *Nutrients*, *13*(2), 1–15. https://doi.org/10.3390/nu13020295

Kelly, B., Hughes, C., Chapman, K., Louie, J. C. Y., Dixon, H., Crawford, J., King, L., Daube, M., & Slevin, T. (2009). Consumer testing of the acceptability and effectiveness of front-of-pack food labelling systems for the Australian grocery market. *Health Promotion International*, *24*(2), 120–129. https://doi.org/10.1093/heapro/dap012

Kennedy, P. E. (1981). Estimation with correctly interpreted dummy variables in semilogarithmic equations. *The American Economic Review*, *71*(4), 801.

Kissock, K. R., Vieux, F., Mathias, K. C., Drewnowski, A., Seal, C. J., Masset, G., Smith, J., Mejborn, H., McKeown, N. M., & Beck, E. J. (2022). Aligning nutrient profiling with dietary guidelines: modifying the Nutri-Score algorithm to include whole grains. *European Journal of Nutrition*, *61*(1), 541–553. https://doi.org/10.1007/s00394-021-02718-6

Koppel, K., & Chambers, D. H. (2012). Flavor Comparison of Natural Cheeses Manufactured in Different Countries. *Journal of Food Science*, *77*(5), 177–187. https://doi.org/10.1111/j.1750-3841.2012.02674.x

Lancaster, K. J. (1966). A New Approach to Consumer Theory. *Current*, *74*(2), 132–157.

Leufkens, D. (2018). The problem of heterogeneity between protected geographical indications: A meta-analysis. *British Food Journal*, *120*, 2843–2856.

List, J. A., & Gallet, C. A. (2001). What Experimental Protocol Influence Disparities Between Actual and Hypothetical Stated Values? Evidence from a Meta-Analysis. In *Environmental and Resource Economics* (Vol. 20).

Lombardi, A., Vecchio, R., Borrello, M., Caracciolo, F., & Cembalo, L. (2019). Willingness to pay for insect-based food: The role of information and carrier. *Food Quality and Preference*, *72*(September 2018), 177–187. https://doi.org/10.1016/j.foodqual.2018.10.001

Lucas, R. E. B. (1975). HEDONIC PRICE FUNCTIONS. *Economic Inquiry*, *13*(2), 157–178. https://doi.org/10.1111/J.1465-7295.1975.TB00985.X

Lusk, J. L., Alexander, C., & Rousu, M. C. (2007). Designing experimental auctions for marketing research: The effect of values, distributions, and mechanisms on incentives for truthful bidding. *Review of Marketing Science*, *5*(February). https://doi.org/10.2202/1546-5616.1059

Lusk, J. L., & Shogren, J. F. (2007). Experimental Auctions: Methods and Applications in Economic and Marketing Research. In *Quantitative Methods for Applied Economics and Business Research* (p. 316). Cambridge University Press (CUP).

Lynch Jr, J. G. (1982). On the external validity of experiments in consumer research. *Journal of Consumer Research*, *9*(3), 225–239.

Manzi, P., Gabriella, M., Costanzo, D., & Ritota, M. (2021). Content and Nutritional Evaluation of Zinc in PDO and Traditional Italian Cheeses. *Molecules*, *26*(20), 6300.

Mazzù, M. F., Romani, S., & Gambicorti, A. (2020). Effects on consumers' subjective understanding of a new front-of-pack nutritional label: a study on Italian consumers. *Https://Doi.Org/10.1080/09637486.2020.1796932*, *72*(3), 357–366. https://doi.org/10.1080/09637486.2020.1796932

Mora-García, C. A., Tobar, L. F., & Young, J. C. (2019). The effect of randomly providing nutri-score information on actual purchases in Colombia. *Nutrients*, *11*(3). https://doi.org/10.3390/nu11030491

Nagle, M. G., & Osorio, T. D. (1993). The tuning of human photopigments may minimize red-green chromatic signals in natural conditions. *Proceedings of the Royal Society B: Biological Sciences*, *252*(1335), 209–213. https://doi.org/10.1098/rspb.1993.0067

Neal, B., Crino, M., Dunford, E., Gao, A., Greenland, R., Li, N., Ngai, J., Ni Mhurchu, C., Pettigrew, S., Sacks, G., Webster, J., & Y Wu, J. H. (2017). Effects of Different Types of Front-of-Pack Labelling Information on the Healthiness of Food Purchases-A Randomised Controlled Trial. *Nutrients*, *9*(12). https://doi.org/10.3390/nu9121284

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M. E., Achoki, T., Albuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., Guzman, N. A., … Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *384*(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8

Noussair, C., Robin, S., & Ruffieux, B. (2004). Revealing consumers' willingness-to-pay: A comparison of the BDM mechanism and the Vickrey auction. *Journal of Economic Psychology*, *25*(6), 725–741. https://doi.org/10.1016/J.JOEP.2003.06.004

Nseir, W., Nassar, F., & Assy, N. (2010). Soft drinks consumption and nonalcoholic fatty liver disease. *World Journal of Gastroenterology*, *16*(21), 2579–2588. https://doi.org/10.3748/wjg.v16.i21.2579

Oczkowski, E. (1994). A HEDONIC PRICE FUNCTION FOR AUSTRALIAN PREMIUM TABLE WINE*. *Australian Journal of Agricultural Economics*, *38*(1), 93–110. https://doi.org/10.1111/j.1467-8489.1994.tb00721.x

Onwezen, M. C., Reinders, M. J., Verain, M. C. D., & Snoek, H. M. (2019). The development of a single-item Food Choice Questionnaire. *Food Quality and Preference*, *71*(May 2018), 34–

45. https://doi.org/10.1016/j.foodqual.2018.05.005

Pettigrew, S., Jongenelis, M. I., Jones, A., Hercberg, S., & Julia, C. (2023). An 18-country analysis of the effectiveness of five front-of-pack nutrition labels. *Food Quality and Preference*, *104*. https://doi.org/10.1016/J.FOODQUAL.2022.104691

Poetschki, K., Peerlings, J., & Dries, L. (2021). The impact of geographical indications on farm incomes in the EU olives and wine sector. *British Food Journal*, *123*(13), 579–598. https://doi.org/10.1108/BFJ-12-2020-1119

Poinsot, R., Vieux, F., Dubois, C., Perignon, M., Méjean, C., & Darmon, N. (2020). Nutritional quality of vegetarian and non-vegetarian dishes at school: Are nutrient profiling systems sufficiently informative? *Nutrients*, *12*(8), 1–17. https://doi.org/10.3390/nu12082256

Qualivita. (2022). *Cresce la filiera IGP della Pasta di Gragnano: produzione + 84% nell'ultimo triennio*. https://www.qualivita.it/news/cresce-la-filiera-igp-della-pasta-di-gragnano-produzione-84-nellultimo-triennio/

Rahkovsky, I., Lin, B. H., Lin, C. T. J., & Lee, J. Y. (2013). *Effects of the Guiding Stars Program on purchases of ready-to-eat cereals with different nutritional attributes*. Food Policy. https://doi.org/10.1016/j.foodpol.2013.08.013

Rayner, M., Scarborough, P., Heart, B., & Health, F. (2009). The UK Ofcom Nutrient Profiling Model. In *UK Ofcom*. https://www.ndph.ox.ac.uk

Resano-Ezcaray, H., & Sanjuàn-Lòpez, I. A. (2008). An hedonic approach applied to scanner data on cured ham purchases in Spain. *12th EAAE Congress 'People, Food and Environments: Global Trends and European Strategies.'* https://doi.org/10.22004/AG.ECON.44383

Resano-Ezcaray, H., Sanjuàn-Lòpez, I. A., & Albisu-Aguado, L. M. (2010). Combining Stated and Revealed Preferences on Typical Food Products: The Case of Dry-Cured Ham in Spain. *Journal of Agricultural Economics*, *61*(3), 480–498. https://doi.org/10.1111/j.1477-9552.2010.00250.x

Roheim, C. A., Asche, F., & Santos, J. I. (2011). The elusive price premium for ecolabelled products: Evidence from seafood in the UK market. *Journal of Agricultural Economics*, *62*(3), 655–668. https://doi.org/10.1111/j.1477-9552.2011.00299.x

Romero Ferreiro, C., Lora Pablos, D., & Gómez de la Cámara, A. (2021). Two dimensions of nutritional value: Nutri-score and nova. *Nutrients*, *13*(8). https://doi.org/10.3390/nu13082783

Rosen, S. (1974). *Hedonic Prices and Implicit Markets: Product Differentiation in Pure*

Competition. http://www.journals.uchicago.edu/t-and-c

Sacks, G., Rayner, M., & Swinburn, B. (2009). Impact of front-of-pack "traffic-light" nutrition labelling on consumer food purchases in the UK. *Health Promotion International*, *24*(4), 344–352. https://doi.org/10.1093/heapro/dap032

Sacks, G., Tikellis, K., Millar, L., & Swinburn, B. (2011). Impact of "traffic-light" nutrition information on online food purchases in Australia. *Australian and New Zealand Journal of Public Health*, *35*(2), 122–126. https://doi.org/10.1111/j.1753-6405.2011.00684.x

Sanjari, S. S., Jahn, S., & Boztug, Y. (2017). Dual-process theory and consumer response to front-of-package nutrition label formats. *Nutrition Reviews*, *75*(11), 871–882. https://doi.org/10.1093/nutrit/nux043

Santé Publique France. (2020). *Nutri-Score*.

Santé Publique France. (2022). *CONDITIONS OF USE OF THE « NUTRI-SCORE » LOGO*.

Santos, O., Alarcão, V., Feteira-Santos, R., Fernandes, J., Virgolino, A., Sena, C., Vieira, C. P., Gregório, M. J., Nogueira, P., Graça, P., & Costa, A. (2020). Impact of different front-of-pack nutrition labels on online food choices. *Appetite*, *154*(August). https://doi.org/10.1016/j.appet.2020.104795

Savelli, E., Bravi, L., Francioni, B., Murmura, F., & Pencarelli, T. (2020). PDO labels and food preferences: results from a sensory analysis. *British Food Journal*, *123*(3). https://doi.org/10.1108/BFJ-05-2020-0435

Savelli, E., Bravi, L., Francioni, B., Murmura, F., & Pencarelli, T. (2021). PDO labels and food preferences: results from a sensory analysis. *British Food Journal*, *123*(3), 1170–1189. https://doi.org/10.1108/BFJ-05-2020-0435

Schamel, G. (2007). Auction markets for specialty food products with geographical indications. *Agricultural Economics*, *37*(2–3), 257–264. https://doi.org/10.1111/J.1574-0862.2007.00272.X

Schulz, L. L., Schroeder, T. C., & White, K. L. (2012). Value of Beef Steak Branding: Hedonic Analysis of Retail Scanner Data. *Agricultural and Resource Economics Review*, *41*(2), 260–273. https://doi.org/10.1017/S1068280500003397

Shangguan, S., Afshin, A., Shulkin, M., Ma, W., Marsden, D., Smith, J., Saheb-Kashaf, M., Shi, P., Micha, R., Imamura, F., & Mozaffarian, D. (2019). A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices. *American Journal of Preventive Medicine*, *56*(2), 300–314. https://doi.org/10.1016/j.amepre.2018.09.024

Shin, S., Puri, J., & Finkelstein, E. (2023). A randomized trial to evaluate the impact of

Singapore's forthcoming Nutri-grade front-of-pack beverage label on food and beverage purchases. *International Journal of Behavioral Nutrition and Physical Activity*, *20*(1). https://doi.org/10.1186/s12966-023-01422-4

Shogren, J. F., Shin, S. Y., Hayes, D. J., & Kliebenstein, J. B. (1994). Resolving Differences in Willingness to Pay and Willingness to Accept Jason F . Shogren , Seung Y . Shin , Dermot J . Hayes and James B . Kliebenstein Source : The American Economic Review , Vol . 84 , No . 1 (. *The American Economic Review*, *84*(1), 255–270.

Sogn-Grundvåg, G., Larsen, T. A., & Young, J. A. (2014). Product Differentiation with Credence Attributes and Private Labels: The Case of Whitefish in UK Supermarkets. *Journal of Agricultural Economics*, *65*(2), 368–382. https://doi.org/10.1111/1477-9552.12047

Stanley, L. R., & Tschirhart, J. (2012). *Hedonic Prices for a Nondurable Good : The Case of Breakfast Cereals Author (s): Linda R . Stanley and John Tschirhart Reviewed work (s): Source : The Review of Economics and Statistics , Vol . 73 , No . 3 (Aug ., 1991), pp . 537-541 Published by : . 73*(3), 537–541.

Staudigel, M., & Trubnikov, A. (2022). High price premiums as barriers to organic meat demand? A hedonic analysis considering species, cut and retail outlet*. *Australian Journal of Agricultural and Resource Economics*, *66*(2), 309–334. https://doi.org/10.1111/1467-8489.12472

Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a Measure of the Motives Underlying the Selection of Food : the Food Choice Questionnaire Department of Psychology , St George ' s Hospital Medical School , London. *Appetite*, *25*, 267–284.

Stiletto, A., Cei, L., & Trestini, S. (2023). A Little Bird Told Me. . . Nutri-Score Panoramas from a Flight over Europe, Connecting Science and Society. *Nutrients*, *15*(15), 3367.

Stiletto, A., & Trestini, S. (2022). Is it really a piece of cake to label Geographical Indications with the Nutri-Score ? Consumers ' behaviour and policy implications. *PLoS ONE*, *17*(11), 1–18. https://doi.org/10.1371/journal.pone.0277048

Storcksdieck Gennat Bonsmann, S., Marandola, G., Ciriolo, E., Van Bavel, R., & Wollgast, J. (2020). *Front-of-pack nutrition labelling schemes: a comprehensive review* (Publications Office of the European Union (ed.)). Publications Office of the European Union. https://doi.org/10.2760/436998

Sutherland, L. A., Kaely, L. A., & Fischer, L. (2010). Comment on Guiding Stars: The effect of a nutrition navigation program on consumer purchases at the supermarket. *Nutrition in Clinical Practice*, *25*(5), 560–561. https://doi.org/10.1177/0884533610379856

Szathvary, S., & Trestini, S. (2014). A Hedonic Analysis of Nutrition and Health Claims on Fruit Beverage Products. *Journal of Agricultural Economics*, *65*(2), 505–517. https://doi.org/10.1111/1477-9552.12056

Talati, Z., Norman, R., Pettigrew, S., Neal, B., Kelly, B., Dixon, H., Ball, K., Miller, C., & Shilton, T. (2017). The impact of interpretive and reductive front-of-pack labels on food choice and willingness to pay. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), 1–10. https://doi.org/10.1186/s12966-017-0628-2

Temple, N. J. (2020). Front-of-package food labels: A narrative review. *Appetite*, *144*(October 2019), 104485. https://doi.org/10.1016/j.appet.2019.104485

Ter Borg, S., Steenbergen, E., Milder, I. E. J., & Temme, E. H. M. (2021). Evaluation of nutri-score in relation to dietary guidelines and food reformulation in the Netherlands. *Nutrients*, *13*(12). https://doi.org/10.3390/nu13124536

Thøgersen, J., & Nohlen, H. U. (2022). *Consumer Understanding of Origin Labeling on Food Packaging and Its Impact on Consumer Product Evaluation and Choices: A Systematic Literature Review.*

Thorndike, E. L. (1920). A Constant Error in Psychological Ratings. *Journal of Applied Psychology*, *4*(1), 25–29. https://ci.nii.ac.jp/naid/30013652235/

Thunström, L., & Rausser, G. (2008). The marginal willingness to pay for health-related food characteristics. *Acta Agriculturae Scandinavica, Section C — Food Economics*, *5*(3–4), 194–206. https://doi.org/10.1080/16507540903064235

Török, Á., & Moir, H. V. J. . (2018). The market size for GI food products – evidence from the empirical economic literature. *Studies in Agricultural Economics*, *120*, 134–142.

Townsend, M. S. (2010). Where is the science? What will it take to show that nutrient profiling systems work? *Erican Journal of Clinical Nutrition*, *91*(4), 1109S-1115S.

Trestini, S., & Stiletto, A. (2020). Does Italian origin really determine a price premium for fluid milk? Evidences from a hedonic price analysis. *Economia Agro-Alimentare*, *22*(1), 1–22. https://doi.org/10.3280/ecag1-2020oa10064

Valenzuela, A., Zambrano, L., Velásquez, R., Groff, C., Apablaza, T., Riffo, C., Moldenhauer, S., Brisso, P., & Leonario-Rodriguez, M. (2022). Discrepancy between Food Classification Systems: Evaluation of Nutri-Score, NOVA Classification and Chilean Front-of-Package Food Warning Labels. *International Journal of Environmental Research and Public Health*, *19*(22), 14631. https://doi.org/10.3390/IJERPH192214631

Vandecandelaere, E., Samper, L. F., Rey, A., Daza, A., Mejía, P., Tartanac, F., & Vittori, M. (2021).

The geographical indication pathway to sustainability: A framework to assess and monitor the contributions of geographical indications to sustainability through a participatory process. *Sustainability (Switzerland)*, *13*(14), 1–20. https://doi.org/10.3390/su13147535

Verbeke, W. (2005). Agriculture and the food industry in the information age. *European Review of Agricultural Economics*, *32*(3), 347–368. https://doi.org/10.1093/EURRAG/JBI017

Vickrey, W. (1961). Counterspeculation, auctions, and competitive sealed tenders. *Journal of Finance*, *16*, 8–37.

Vlassopoulos, A., Katidi, A., Savvidou, T., & Kapsokefalou, M. (2022). Alignment of Nutri-Score with Mediterranean Diet Pyramid: A Food Level Analysis. *Nutrients*, *14*(23). https://doi.org/10.3390/nu14235097

Vyth, E. L., Steenhuis, I. H., Vlot, J. A., Wulp, A., Hogenes, M. G., Looije, D. H., Brug, J., & Seidell, J. C. (2010). Actual use of a front-of-pack nutrition logo in the supermarket: consumers' motives in food choice. *Public Health Nutrition*, *13*, 1882–1889. https://doi.org/10.1017/S1368980010000637

WHO. (2019). *Guiding principles and framework manual for front-of- pack labelling for promoting healthy diet*.

WHO. (2020a). *Appendix: Detailed description of additional validation studies that may be considered to select and evaluate a front-of-pack labelling scheme*.

WHO. (2020b). *World health statistics 2020: monitoring health for the SDGs, sustainable development goals.*

Withall, J., Jago, R., & Cross, J. (2009). Families' and health professionals' perceptions of influences on diet, activity and obesity in a low-income community. *Health and Place*, *15*(4), 1078–1085. https://doi.org/10.1016/j.healthplace.2009.05.006

Włodarek, D., & Dobrowolski, H. (2022). Fantastic Foods and Where to Find Them—Advantages and Disadvantages of Nutri-Score in the Search for Healthier Food. *Nutrients*, *14*(22). https://doi.org/10.3390/nu14224843

Wongprawmas, R., Mora, C., Pellegrini, N., Guiné, R. P. F., Carini, E., Sogari, G., & Vittadini, E. (2021). Food choice determinants and perceptions of a healthy diet among Italian consumers. *Foods*, *10*(2). https://doi.org/10.3390/foods10020318

World Health Organization. (2020). World health statistics 2020: monitoring health for the SDGs, sustainable development goals. In *Geneva: World Health Organization; 2020.*

Licence:

World Health Organization. (2021). *Malnutrition: Fact sheets*. https://www.who.int/news-room/fact-sheets/detail/malnutrition#:~:text=1.9 billion adults are overweight,million were overweight or obese.

Zhang, G., Wang, C. L., Liu, J., & Zhou, L. (2023). Why do consumers prefer a hometown geographical indication brand? Exploring the role of consumer identification with the brand and psychological ownership. *International Journal of Consumer Studies*, *47*(1), 74–85. https://doi.org/10.1111/ijcs.12806

Zhang, S., Sun, Y., Yu, X., & Zhang, Y. (2023). Geographical Indication, Agricultural Products Export and Urban–Rural Income Gap. *Agriculture (Switzerland)*, *13*(2), 1–16. https://doi.org/10.3390/agriculture13020378

Chapter 7

Conclusions

Nowadays, the NS debate is gaining more and more attention from both the scientific and public sides (Stiletto et al., 2023). The European Commission, within the F2F Strategy, emphasizes the need to have a mandatory FOP nutrition labeling system on pre-packaged foods, which is homogeneous across the European Union. In this context, the NS stands out as the most promising candidate for FOP labeling, being largely recognized as the most effective in assisting consumers in discerning products based on their nutritional content (Drewnowski et al., 2021; Pettigrew et al., 2023). This upswing in interest has sparked research initiatives exploring different facets of NS, including comparisons with other FOP labels in terms of consumer perception and comprehension (Egnell et al., 2018; Pettigrew et al., 2023), exploring its impact on promoting healthier choices (Fuchs et al., 2022; Shin et al., 2023), or evaluating the nutritional quality of foods based on their NS ratings (Poinsot et al., 2020). However, despite the extensive endeavors undertaken by the scientific community, the European Commission has postponed the decision on nutritional FOP to be adopted at the Union level to the next EU legislature, due to the lack of evidence to support a given FOPL (Stiletto et al., 2023).

Indeed, political tensions are surrounding the adoption of the NS, with various Member States expressing strong opposition to this label. This is particularly evident in Italy, where the NS adoption is a recurrent topic in the agricultural political debate (Stiletto et al., 2023). In this context, the national government is aligned with prominent agri-food companies (Morgane Fialon et al., 2022), who argue that NS acts as a penalizing measure against Mediterranean and traditional products (Morgane Fialon et al., 2022; Stiletto & Trestini, 2022), including wines. Similarly, in Spain, where the Nutri-Score was officially introduced in 2021, concerns have repeatedly arisen regarding perceived inconsistencies in the classification of certain traditional products, such as olive oil (Fialon et al., 2021), followed by a slight adjustment in the NS algorithm, which provides a more comprehensive assessment of the nutritional qualities of products, including also olive oil.

In light of these discussions, there is the clear need to shed some lights on the contrasting positions existing within the European context, to reach a general agreement among the Member States. On the other side, it is particularly important to understand which are the most debated topics, raised at the public level, not widely investigated by the scientific literature, to direct scientific research and fill these gaps, thus allowing the European Commission to take a thoughtful decision on the nutrition FOP label to be adopted. The first paper presented in the thesis (reported in Chapter 3) answered this research question, highlighting how scientific research and public debate often run on different tracks. Indeed, if on the one hand the positive aspects that strengthen and support the adoption of NS have been widely discussed by the scientific community, on the other one, little is known about the though aspects linked to the Common use of this label. Researchers broadly tested consumers' understanding of different FOP labels, stressing the self-explanatory nature of the NS (see for instance Escalon et al., 2021; Pettigrew et al., 2023) and its ability in guiding consumers towards healthier choices (Hock et al., 2021; Jansen et al., 2021), with a consequent and positive impact on the health status of the citizens (Deschasaux et al., 2018). However, the existing literature lacks in examining how this labeling system might influence market dynamics, from both producers' and consumers' sides. Indeed, scientists has not investigated enough the factors behind the reluctance of several producers towards this label, neither analyzing from a scientific point of view the indictments made by firms, thus making it difficult to unravel the knot. This is particularly applicable to GIs, which suffer more than others the effects of the NS adoption. Indeed, GI producers face greater challenges when attempting to modify their products to improve their NS level, thus reflecting the general ambitions to reformulate processed products under the F2F strategy, as they are bound by specific production specifications they must adhere to (Stiletto & Trestini, 2022). Just think of the recent proposal for an amendment of the Prosciutto San Daniele Consortium, asking for the reduction of the content of salt in their products to better fit the World Health Organization goals (without compromising the taste of the product), which has not been not authorized yet, being considered a major change by the European Commission (Höhn et al., 2023).

Furthermore, it can be broadly assumed that the NS system casts a negative light on the GI category. Although a significant proportion of GIs (in terms of number) consists of fruits and vegetables, which typically receive a favorable NS rating, it's worth noting that the most economically valuable GI products are those of animal origin – accounting for about 52.0% of market share in Europe – which tend to be negatively labeled by the NS system (ISMEA, 2021).

This is all the more important considering that NS does not apply on products sold loose, as the majority of PDO and PGI fruits and vegetables. Consequently, as consumers predominantly encounter the NS on GIs classified as "products to be limited in consumption", there's a risk that they may extend the negative perception of the NS from animal-origin products to the entire Geographical Indication sector. The prevailing consumer confusion is exacerbated by the apparent conflict in policies governing PDO and PGI products, a topic extensively examined in this thesis. On one hand, these products are promoted and safeguarded for their superior quality, closely intertwined with the region of origin and traditional know-how. On the other hand, the same products are mainly classified as goods to limit or avoid in dietary consumption according to the F2F strategy, endorsed by the NS. This incongruity creates a challenging scenario for both consumers and the GI sector and deserve further investigation.

Chapters 4, 5, and 6 of this Thesis deeply focused on this issue. Specifically, Chapter 4 can be considered a pioneer attempt to measure Italian consumers' preferences for PDO and PGI products labeled with the NS. The outcomes of this study, of a hypothetical nature, shed light on the pivotal role of familiarity with the label in shaping consumer preferences. The findings revealed that consumers, when not adequately informed about the label, tended to misinterpret the NS, resulting in behaviors and stated preferences that reflected this confusion. This aspect underlines, once again, the importance of not considering the NS as the *deus-ex machina* to solve the dietary problems of the European population. It aligns with the stance of NS promoters themselves, who assert that this policy cannot be considered a substitute for general public health recommendations or, more specifically, for food-based dietary guidelines that are designed to steer consumers toward healthier dietary choices. Both approaches are unquestionably complementary (Hercberg et al., 2022).

The NS, as the rest of FOP nutrition labels, constitutes just one component within a comprehensive public health nutrition strategy. It completes other public health initiatives, especially nutrition education, communication regarding general dietary guidelines, regulations governing marketing and advertising, and the implementation of taxation and subsidy programs aimed at enhancing access to nutritionally and healthy food for everyone (Hercberg et al., 2022). Along with this aspect, education campaigns describing the nature and the role of NS is fundamental to reach the F2F objectives. Indeed, the role of information and misinterpretation of the label has emerged as a recurring result through all the other articles of this thesis. Even when provided with information about the nature of the NS, Italian consumers appear to struggle in comprehending the label fully, as confirmed by the results of the EA

(Chapter 5). Failing to grasp the information reported on the label correctly, some consumers seem to prefer products with negative NS values over those evaluated positively. This aspect is strongly influenced by the lack of familiarity of Italian consumers with the NS (Santos et al., 2020; Stiletto & Trestini, 2022) and leads to possible delays in achieving the objectives set by F2F Strategy, stressing once again the need for complementary strategy to improve the dietary habits of the population.

Nonetheless, the *file rouge* that links all the articles in this thesis is the impact of the NS on GIs market and the inherent inconsistencies within the system. The outcomes of the research have underscored how PDO and PGI products are effectively penalized by the use of the NS. This is primarily because this label decrease consumers' willingness to pay for GIs negatively evaluated by this system (Chapter 4 and Chapter 5). Furthermore, it narrows the gap between PDO and PGI products and their conventional counterparts (Chapter 5), and negatively affects the selling prices of these products (Chapter 6). This finding holds significant implications for the agri-food sector, especially in the field of GIs, and allows consumers' choices to be "forecast". Indeed, when the NS system becomes mandatory across all EU countries, and consumers become more familiar with this labeling system, Italians' consumption patterns may shift towards rejecting GI products, especially considering those of animal origin, in favor of "healthier" alternatives, such as industrial, processed, or reformulated foods (Vyth et al., 2010). This potential shift could lead to a foreseeable decline in the sales value of GIs products, which constitute a cornerstone of the EU's quality policy within the food sector and are, in general, less processeed than their conventional counterparts (Höhn et al., 2023). This would have important repercussions on the agri-food sector, considering that GIs play a fundamental role in safeguarding the diverse typical and cultural heritage of the EU, enhancing, at the same time, the value of traditional agricultural products, boosting producers' income (Poetschki et al., 2021). Furthermore, GIs have a positive impact on rural development, which is particularly important in marginalized and less favored areas, where GIs contribute to bridge the economic gap with wealthier regions (Zhang et al., 2023).

Besides, the tendency of consumers to reduce the premium in value given to GIs when compared to conventional products if labelled with the NS reinforce its negative effect on PDO and PGI goods. In Chapter 5, results underlined how the consumers in the sample, discovering that GI products have the same NS level – and therefore similar nutritional values – of their conventional counterparts, tend to allocate higher value to the conventional products, reducing the value gap between the two goods and undermining the ability of GIs to convey information

properly. Indeed, the primary objective of GIs system is to reduce the information asymmetry between producers and consumers, by emphasizing the quality attributes of these products, strictly link to local, natural, and human factors. Although a superior nutritional quality of GIs is not guarantee by this certification, consumers often tend to value GIs not only as traditional products, but also as healthy goods (Glogoveţan et al., 2022; Thøgersen & Nohlen, 2022). This tendency is gaining more and more support from the scientific community, with researches finding that PDO and PGI products generally prohibit the use of chemical food additives, resulting as less processed and more genuine and natural goods (Glogoveţan et al., 2022; Höhn et al., 2023). This is particularly important when considering that even in low doses some additives can be harmful, as stressed by Chazelas et al. (2020) and (2021), and considering that NS profiling system do not consider these aspects in the classification.

In summary, the general findings of this thesis stress the significant and negative impact of the NS on the sales dynamics of GI products, especially if negatively evaluated by this labeling system. However, it's important to note that this negative effect is not homogeneous across all the GIs investigated. Indeed, one of the most renowned Designations, such as Parmigiano Reggiano PDO, appear to be relatively unaffected by the adoption of the NS. This could be associated to the positive value associated with the GI, which effectively offsets the negative value attributed to the presence of the NS. Nevertheless, this situation could exacerbate challenges within the GI context, potentially mining the path of less reward GIs towards the expected success. It is well-known that the price premium for GIs is generally product and GI dependent (Deselnicu et al., 2013; Leufkens, 2018), with consumers considering Consortia label as private brand (Arfini, 1999). In this context, consumers typically exhibit a stronger inclination to purchase well-known and hometown GIs, as Parmigiano Reggiano PDO in the Italian market[17], considering that the connection between consumers and these products is more robust in this case, with consumers more engage with the GI brand (Zhang et al., 2023). In broad terms, it can be observed that GIs with a stronger reputation are more resilient, as they are less adversely impacted by negative attributes, like negative NS, when compared to less popular GIs. Nevertheless, this phenomenon seems to contradict the overarching goals of GIs, which seek to bolster marginalized and rural regions while increasing producers' incomes. In fact, GIs system seems able to protect only the most renowned and well-established

[17] This partially explain why the Parmigiano Reggiano PDO "protects" the product from the negative effect of NS in the Italian market, while opposite results have been found for an equally famous GI, namely the Parma PDO Ham, in France, where the brand-consumer relationship is less strong (Chapter 5).

Designations, which are already robust from an economic perspective, penalizing most of the GIs located in the marginal areas.

In conclusion, to guarantee to the NS label to be an effective and efficient public health tool, it becomes imperative to understand deeper the potential drawbacks of the NS system. Factors such as the lack of familiarity among certain European consumers with the NS, misinterpretation of the label, and opposition to the system could result in delays in achieving the stated objectives, thereby deviating from the F2F strategy's timeline. Considering more specifically the impact of the NS on GIs, a more thorough understanding of the labeling system among consumers could alleviate the political tensions. If products of animal origin, whether GI or not, labeled with a negative NS were effectively recognized as items not to be consumed frequently, aligning with the principles of the Mediterranean Diet, rather than being considered unhealthy or products to be avoided, it's possible that consumers' perceptions of these goods could evolve positively. In fact, the findings highlighted a lack of harmonization in describing products according to their level of NS, not only from the consumers side, but also considering researchers. Similarly, if the superior quality of GIs products were acknowledged, bolstered by their naturalness and absence of food additives, we might even witness an upswing in sales of these products, following the "less but better" perspective.

While this thesis represents a first approach to the issue, further research in this field is necessary, especially given the pivotal role that consumer information plays in the success of this policy. It is crucial to explore the most effective methods for explaining the label to Italian consumers, as well for the other less-familiar consumers all over Europe, to facilitate the improvement of their consumption habits, moving towards healthier products or better consumption patterns. Moreover, there is a clear need to investigate whether there are tangible ways to alleviate the tension between NS and GIs. For instance, it is essential to shed some lights on production specifications rules, assessing whether there could be some flexibility in the pure nutritional modifications of the product that do not compromise the intrinsic quality, which is derived from natural and human factors. Simultaneously, it is necessary to clarify whether the NS has reached its optimal form or if further enhancements are possible, considering, for example, the micronutrient content or the reduction in the use of harmful additives of products as part of the assessment criteria.

References

Arfini, F. (1999). The value of typical products: the case of Prosciutto di Parma and Parmigiano Reggiano cheese. *The Socio-Economics of Origin Labelled Products: Spatial, Institutional and Co-Ordination Aspects*, 78–97. http://ageconsearch.umn.edu/record/241032/files/Arfini _1999_ The value of typical products.pdf

Chazelas, E., Deschasaux, M., Srour, B., Kesse-Guyot, E., Julia, C., Alles, B., Druesne-Pecollo, N., Galan, P., Hercberg, S., Latino-Martel, P., Esseddik, Y., Szabo, F., Slamich, P., Gigandet, S., & Touvier, M. (2020). Food additives: distribution and co-occurrence in 126,000 food products of the French market. *Scientific Reports*, *10*(1), 1–15. https://doi.org/10.1038/s41598-020-60948-w

Chazelas, E., Druesne-Pecollo, N., Esseddik, Y., de Edelenyi, F. S., Agaesse, C., De Sa, A., Lutchia, R., Rebouillat, P., Srour, B., Debras, C., Wendeu-Foyet, G., Huybrechts, I., Pierre, F., Coumoul, X., Julia, C., Kesse-Guyot, E., Allès, B., Galan, P., Hercberg, S., … Touvier, M. (2021). Exposure to food additive mixtures in 106,000 French adults from the NutriNet-Santé cohort. *Scientific Reports*, *11*(1), 1–21. https://doi.org/10.1038/s41598-021-98496-6

Deschasaux, M., Huybrechts, I., Murphy, N., Julia, C., Hercberg, S., Srour, B., Kesse-Guyot, E., Latino-Martel, P., Biessy, C., Casagrande, C., Jenab, M., Ward, H., Weiderpass, E., Dahm, C. C., Overvad, K., Kyrø, C., Olsen, A., Affret, A., Boutron-Ruault, M.-C., … Touvier, M. (2018). Nutritional quality of food as represented by the FSAm-NPS nutrient profiling system underlying the Nutri-Score label and cancer risk in Europe: Results from the EPIC prospective cohort study. *PLOS Medicine*, *15*(9), e1002651. https://doi.org/10.1371/journal.pmed.1002651

Deselnicu, O. C., Costanigro, M., Souza-Monteiro, D. M., & McFadden, D. T. (2013). A Meta-Analysis of Geographical Indication Food Valuation Studies: What Drives the Premium for Origin-Based Labels? *Journal of Agricultural and Resource Economics*, *2*, 204–219.

Drewnowski, A., Amanquah, D., & Gavin-Smith, B. (2021). Perspective: How to Develop Nutrient Profiling Models Intended for Global Use: A Manual. *Advances in Nutrition*, *12*(3), 609–620. https://doi.org/10.1093/advances/nmab018

Egnell, M., Ducrot, P., Touvier, M., Allès, B., Hercberg, S., Kesse-Guyot, E., & Julia, C. (2018). Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: Comparisons with other format labels. *PLoS ONE*, *13*(8). https://doi.org/10.1371/journal.pone.0202095

Escalon, H., Courbet, D., Julia, C., Srour, B., Hercberg, S., & Serry, A. J. (2021). Exposure of french children and adolescents to advertising for foods high in fat, sugar or salt. *Nutrients*, *13*(11). https://doi.org/10.3390/nu13113741

Fialon, M., Salas-Salvadó, J., Babio, N., Touvier, M., Hercberg, S., & Galan, P. (2021). Is FOP nutrition label nutri-score well understood by consumers when comparing the nutritional quality of added fats, and does it negatively impact the image of olive oil? *Foods*, *10*(9). https://doi.org/10.3390/foods10092209

Fialon, Morgane, Nabec, L., & Julia, C. (2022). Legitimacy of Front-of-Pack Nutrition Labels: Controversy Over the Deployment of the Nutri-Score in Italy. *International Journal of Health Policy and Management*, *11*(11), 2574–2587. https://doi.org/10.34172/ijhpm.2022.6127

Fuchs, K. L., Lian, J., Michels, L., Mayer, S., Toniato, E., & Tiefenbeck, V. (2022). Effects of Digital Food Labels on Healthy Food Choices in Online Grocery Shopping. *Nutrients*, *14*(10),

2044. http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=84403754&site=ehost-live

Glogoveţan, A. I., Dabija, D. C., Fiore, M., & Pocol, C. B. (2022). Consumer Perception and Understanding of European Union Quality Schemes: A Systematic Literature Review. *Sustainability 2022, Vol. 14, Page 1667*, *14*(3), 1667. https://doi.org/10.3390/SU14031667

Hercberg, S., Touvier, M., & Salas-salvado, J. (2022). The Nutri-Score nutrition label. *International Journal for Vitamin and Nutrition Research*, *92*(3–4), 147–157.

Hock, K., Acton, R. B., Jáuregui, A., Vanderlee, L., White, C. M., & Hammond, D. (2021). Experimental study of front-of-package nutrition labels' efficacy on perceived healthfulness of sugar-sweetened beverages among youth in six countries. *Preventive Medicine Reports*, *24*. https://doi.org/10.1016/j.pmedr.2021.101577

Höhn, G. L., Huysmans, M., & Crombez, C. (2023). Healthy food traditions? Nutritional quality and food composition of EU geographical indications. *Q Open*, *3*(1), 1–20. https://doi.org/10.1093/qopen/qoad014

ISMEA. (2021). *RAPPORTO ISMEA - QUALIVITA 2021 sulle produzioni vitivinicole e agroalimentari DOP Italia*.

Jansen, L., van Kleef, E., & Van Loo, E. J. (2021). The use of food swaps to encourage healthier online food choices: a randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1), 1–16. https://doi.org/10.1186/s12966-021-01222-8

Leufkens, D. (2018). The problem of heterogeneity between protected geographical indications: A meta-analysis. *British Food Journal*, *120*, 2843–2856.

Pettigrew, S., Jongenelis, M. I., Jones, A., Hercberg, S., & Julia, C. (2023). An 18-country analysis of the effectiveness of five front-of-pack nutrition labels. *Food Quality and Preference*, *104*. https://doi.org/10.1016/J.FOODQUAL.2022.104691

Poetschki, K., Peerlings, J., & Dries, L. (2021). The impact of geographical indications on farm incomes in the EU olives and wine sector. *British Food Journal*, *123*(13), 579–598. https://doi.org/10.1108/BFJ-12-2020-1119

Poinsot, R., Vieux, F., Dubois, C., Perignon, M., Méjean, C., & Darmon, N. (2020). Nutritional quality of vegetarian and non-vegetarian dishes at school: Are nutrient profiling systems sufficiently informative? *Nutrients*, *12*(8), 1–17. https://doi.org/10.3390/nu12082256

Santos, O., Alarcão, V., Feteira-Santos, R., Fernandes, J., Virgolino, A., Sena, C., Vieira, C. P., Gregório, M. J., Nogueira, P., Graça, P., & Costa, A. (2020). Impact of different front-of-pack nutrition labels on online food choices. *Appetite*, *154*(August). https://doi.org/10.1016/j.appet.2020.104795

Shin, S., Puri, J., & Finkelstein, E. (2023). A randomized trial to evaluate the impact of Singapore's forthcoming Nutri-grade front-of-pack beverage label on food and beverage purchases. *International Journal of Behavioral Nutrition and Physical Activity*, *20*(1). https://doi.org/10.1186/s12966-023-01422-4

Stiletto, A., Cei, L., & Trestini, S. (2023). A Little Bird Told Me. . . Nutri-Score Panoramas from a Flight over Europe, Connecting Science and Society. *Nutrients*, *15*(15), 3367.

Stiletto, A., & Trestini, S. (2022). Is it really a piece of cake to label Geographical Indications with the Nutri-Score ? Consumers ' behaviour and policy implications. *PLoS ONE*, *17*(11), 1–18. https://doi.org/10.1371/journal.pone.0277048

Thøgersen, J., & Nohlen, H. U. (2022). *Consumer Understanding of Origin Labeling on Food Packaging and Its Impact on Consumer Product Evaluation and Choices: A Systematic Literature Review.*

Vyth, E. L., Steenhuis, I. H., Vlot, J. A., Wulp, A., Hogenes, M. G., Looije, D. H., Brug, J., & Seidell, J. C. (2010). Actual use of a front-of-pack nutrition logo in the supermarket: consumers' motives in food choice. *Public Health Nutrition*, *13*, 1882–1889. https://doi.org/10.1017/S1368980010000637

Zhang, S., Sun, Y., Yu, X., & Zhang, Y. (2023). Geographical Indication, Agricultural Products Export and Urban–Rural Income Gap. *Agriculture (Switzerland)*, *13*(2), 1–16. https://doi.org/10.3390/agriculture13020378