FACTS BEHIND FOOD CERTIFICATIONS: CONSUMER DEMAND FOR ORGANIC AND NON-GMO PLANT-BASED MILK PRODUCTS WITH REDUNDANT LABELING AND CERTIFICATION EXCEPTIONS

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ABSTRACT

Consumers rely on the information on food packages to make informed choices. However, manufacturers may sometimes adopt inefficient labeling to establish a superior product image and charge price premiums. This study first focuses on labeling redundancy implied by the USDA Organic Seal and Non-GMO Project Verified (NGPV) mark on plant-based milk products, and statistically evaluates the price premiums attributable to their existence. In addition, this study characterizes and examines a second form of labeling inefficiency: trace amounts of unqualified ingredients permitted by certifying entities but not explicitly communicated to consumers. The researcher utilizes an innovative, incentive-compatible online survey with randomized information treatments to collect respondents' willingness to pay for certified plant-based milk products, and quantifies the impact of enhanced consumer knowledge about the underlying facts.

In short, exact dollar amounts associated with multiple forms of labeling inefficiency and information treatments are calculated; distinctive preferences are identified among consumers with dairy sensitivities and vegan or vegetarian status, as the former group preferred soy milk while the latter one favored oat milk; demand for oat milk decreased as consumer's age increased; single presence of the USDA Organic Seal was more attractive than NGPV mark; there was a diminishing return instead of

any synergy for dual-labeling; the product type of oat, age, household income and single presence of either the USDA Organic Seal or NGPV mark were significant stimuli attracting people to adopt soy and oat milk products; the public was relatively more informed about USDA Organic criteria; there was a strong bias among people who self-identified as being familiar with NGPV criteria; and finally, information about certification exceptions actually increased consumer WTP under the specific conditions of this study. Results of this study could facilitate consumer education, firm decisions and policymaking.

BIOGRAPHICAL SKETCH

Geqing Zhou was born in Shenyang, China. After completing his schoolwork at Liaoning Province Shiyan High School in 2015, Geqing attended the University of California, San Diego. He received a Bachelor of Science Degree in Joint Major Math and Economics in March, 2019. Geqing entered the graduate program of Applied Economics and Management at Cornell University in August, 2019 with a concentration in Food and Agricultural Economics.

DEDICATION

值此毕业之际，我首先要感谢我亲爱的母亲，阎巍女士。语言难以歌颂您为我所倾注的心血，是您对教育的重视使我如今成为了一个有思想和格局的人。我十分珍惜您用勤劳为我们的家庭带来的生活，您的能力、视角与个性永远是我学习的榜样。在我的海外求学生涯当中，您是我的坚强后盾。每当我面临抉择，您总是能在鼓励我独立思考的同时为我排忧解难。我也要感谢姥姥和其他家人们：即使我们大洋相隔、我所喜爱的专业听起来陌生，但你们总是对我表达出百分之百的支持。

我的伴侣闻晴是我学习、事业与成长的关键支柱。与硕士项目同步开始的这段爱情，带来了无数我们之间的专属回忆。两年间，我所有的研究、备考与工作都有你在背后的照顾，在伊萨卡的时光也标志了你和我的共同进步。我们不乏上天入海，也曾一起挑灯夜读，人生路上有你的陪伴我感激不尽。未来可期，属于我们的故事从此刻刚刚开始。我也同时感谢晴的父母闻博士与吕博士对我们生活的关心以及对我个人发展的宝贵意见。

最后，我想将这篇文章献给我的姥爷。我清晰记得在我五岁时您骑车送我上学的每个清晨，也是您偶尔的严厉让我变得谦卑。未能与您赴钓鱼之约，是我永远的遗憾。在探索这繁浩世界之时，我的心中一直有您。愿您在那里安好。

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INTRODUCTION

Food and drink labels are often expected to provide consumers with salient information and assist them in making unbiased, informed purchasing decisions. However, it has been a known issue that people's understanding of such information is often incomplete or erroneous, leading to inefficiency of various degrees. One study on food expiry dates unveiled that a majority of US consumers mistakenly regarded "best by" or "expires on" as quality or safety labels (Neff et al., 2019). Another study on infant formula labels found that even highly educated caregivers experienced difficulties with the ingredient list and nutrition information statement (Malek, Fowler, Duffy and Katzer, 2018). For front-of-package nutrition symbols, consumers appeared to be misled instead of benefited by calorie, sodium and fat information (Miller et al., 2015). Meanwhile, labels regulated at federal and state levels, such as the Nutrition and Supplement Facts label (Fang et al., 2019), CA Proposition 65 Warning (Polsky and Schwarzman, 2020) and the Added Sugar label (McDonough, 2015) have historically demonstrated a better performance in serving the informing function.

The USDA Organic Seal is a federally regulated mark. It guarantees that the certified merchandise contains 95% or more organic contents, is free of most synthetic additives like pesticides, chemical fertilizers and dyes, and has not been processed using industrial solvents, irradiation or genetic engineering. The wide acceptance of

certified organic food is confirmed by its outstanding market growth: organic food sales in the US reached an all-time high of $56.5 billion in 2020, a 4.3 times increase since 2005 (Statista, 2022).

Genetic engineering, also named genetic modification (GM), is the human intervention with an organism's genetic makeup to transfer or amplify desired genes and traits. According to the most recent guidance by FDA (2022), GM foods are generally safe for consumption, yet some critical health considerations including allergic reactions and antibiotic resistance (Uslu, 2021) remain under scrutiny by the scientific field. Such uncertainty partly contributes to the fact that many consumers express concerns about GM food: a 2019 survey showed that 51% of Americans believed GM food was inferior health-wise (Funk, 2020). Amid the debates, consumers' right to be informed and their preferences for either GM or non-GMO foods are being increasingly recognized, as seen in the federally mandated Genetically Engineered (GE) labeling that firms must comply with starting January 1, 2022.

Compared to the GE label that just took effect, Non-GMO Project Verified (NGPV) is a well-recognized mark developed by the non-profit organization of the Non-GMO Project founded in 2007. The NGPV mark pledges the certified commodity's compliance with the organization's standard of testing, procurement and traceability against the presence of genetically modified organisms. The federal government does not yet regulate this designation and other non-GMO labels.

A fully informed consumer should know that there are only eleven commercially available GM crops in the US (Sims, 2018), meaning that many food products do not have their GM versions to begin with. She should also know that GM ingredients are already prohibited in USDA Organic products (USDA, 2017). However, manufacturers have the option to label their products made from ingredients incapable of being genetically engineered as NGPV, or step forward to include both certifications on their packaging and create even more inefficiency. Throughout this study, the concept of labeling redundancy (LR) is defined and will be used as follows:

Table 1: definitions and examples of labeling redundancy (LR)

Labeling Redundancy Type I (LR I)	**Labeling Redundancy Type II (LR II)**
NGPV mark on USDA Organic products made with ingredients that have GM versions, or the "reiteration": USDA Organic products are already non-GMO in general terms. Example: dual-labeled soy milk	NGPV mark on products made with ingredients that do not have GM versions, or the "impossibility": such products are always non-GMO. Example: NGPV oat milk
Dual Redundancy (DR)	
A product made from ingredients that cannot be genetically engineered carrying both the USDA Organic Seal and NGPV mark. Both types of Labeling Redundancy are present in this scenario. Example: dual-labeled oat milk	

In addition to LR, there is also a substantial risk that consumers may not capture all the pertinent facts behind food certifications and, therefore, use their perceptions to fill the information-decision gap. Specifically, the USDA publishes the following exceptions for certification applicants and holders: USDA Organic products can contain non-organic ingredients up to 5% in weight or fluid volume; these ingredients include

materials with no widely available organic versions, processing aids, and synthetic materials on a dedicated list of approved substances, with examples like cattle vaccines and pectin. This suggests that a USDA Organic product is effectively 95% to 100% organic without further specifications. The NGPV standard also outlines scenarios where GM ingredients may not necessitate disqualifications: for example, NGPV products can contain a trace amount of GM ingredients up to 0.9% in total weight, if the manufacturer used a fortification or preservative that accidentally contained a small amount of GMOs. Another example would be the adventitious presence of GMO soy in trace amounts in a non-GMO soy commodity. Thus, non-GMO or NGPV is not equivalent to GMO-free.

Given the amounts of unqualified ingredients permitted by the certifying entities and the absence of a conclusive link between consumption doses and GM safety (Butler and Reichhardt, 1999) or the nutritional value of organic products (Vigar et al., 2020), another form of labeling inefficiency, implicitly communicated certification exceptions (CE), is present: USDA Organic and NGPV products may contain ingredients that do not comply with certification standards, but people could not tell such possibility or the relevant thresholds merely from the labels. Thus, consumers with strict preferences for non-GMO who adhere to NGPV products and assume them to be GMO-free may end up with undesirable situations; a less experienced shopper for USDA Organic products may also be unaware of the 95% rule and make biased decisions as a result.

The failure to fully disclose trace amounts of unqualified ingredients contrasts with the industry standard of making “May Contain" allergen statements. These statements are largely precautionary in nature by suggesting the possible inadvertent presence of allergens and are not regulated by the FDA, but still provide an extra layer of protection especially for allergic individuals. A study conducted by Marra et al. (2017) revealed that most consumers were willing to receive additional allergen disclosures on grocery products at their own expenses, up to $10 extra per month.

Despite the rooted culture of drinking liquid cow milk, a staple food since the 20th century when the public was looking for a simple choice to complement the health movements (Greenwood, 2015), the US per capita consumption of cow milk has decreased by 28% since 2000 (Statista, 2021). In contrast, plant-based milk embraces a growth made possible by improved production methods such as nutrition fortification and the passive demand driven by vegan diets, lactose intolerance and dairy allergy (Settembre, 2019). USDA Economic Research Service (2020) identified a 36% increase in the consumption of plant-based alternatives from 2013 to 2017; another marketing research suggested that sales of non-dairy milk had seen a 62% increase from 2012 to 2017 (Mintel, 2018). The market of alternative milk products is currently dominated by varieties including soy, oat and coconut (Paul, Kumar, Kumar and Sharma, 2019).

The goals of this study include but are not limited to: testing if LR is a critical factor in determining consumer WTP for plant-based milk products; evaluating the

amount of price premium that LR generates, if there is any; gauging people's existing knowledge of trace amount allowed in USDA Organic and NGPV products; capturing the effects of information provisions on LR and CE on WTP; and finally, soliciting opinions regarding mandatory disclosure of trace ingredients by certified products. Under the evolving global pandemic situation, these goals are achieved by conducting an innovative, incentive-compatible online survey on 250 human participants and adhering to the applicable mechanism of eliciting consumer WTP.

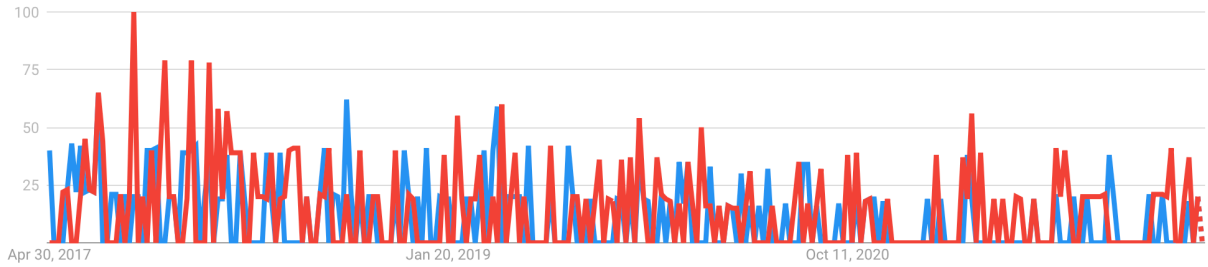
As a preview of the results in this study, the price premium stemming from LR I was \$0.17, \$0.54 for LR II, and \$0.39 for DR. Depending on the product type, the criteria group paid \$0.74 to \$0.98 less than the control group after being exposed to information about LR. The information treatments affected demands for all products presented in the study systematically. Dairy sensitive participants preferred soy milk, while vegan or vegetarian participants favored oat milk. Demand for oat milk decreased as consumer's age increased. Single presence of the USDA Organic Seal was more attractive than NGPV mark. Instead of any synergy, there was a diminishing return for participating in both USDA Organic and NGPV programs. The product type of oat, age, household income and single presence of either the USDA Organic Seal or NGPV mark were significant stimuli attracting people to adopt soy and oat milk products. The public was relatively more informed about USDA Organic criteria, while there was a strong bias among people who self-identified as familiar with NGPV criteria. Finally, based on the

behaviors of the full group, information about CE actually increased consumer WTP for certified plant-based milk products.

BACKGROUND

Much of the existing coverage on redundant labeling solely focused on the presence of LR I, namely organic products carrying non-GMO designations. For example, Conner and Christy (2004) found that participants were willing to pay $0.40 for the non-GMO claim on the package of organic corn chips, and only 53% of them knew that organic already meant free from GMOs; McFadden and Lusk (2017) used GM apples and granola bars as the baseline and found that coexistence of the USDA Organic Seal and NGPV mark entailed a positive, sometimes the highest, price premium. On the other hand, a benchmark study on LR II conducted by Wilson and Lusk (2020) revealed that around 47% of consumers were willing to pay a premium for non-GMO sea salt, and information about the redundancy substantially reversed their preferences mid-experiment. However, non-GMO salt appears to be a relatively better-known example: in the most recent five-year period, the term "Non GMO Salt" on Google received its highest search interest in September 2017, which was 1.6 times more than the peak of the legitimate "Non GMO Soy Milk"; searches for other terms such as "Non GMO Oat Milk" and "Non GMO Plant Based Milk" were too scarce to be indexed (Google Trends, 2022):

Figure 1: Google Trends of the search terms "Non GMO Salt" (in red) and "Non GMO Soy Milk" (in blue) from April 2017 to April 2022



As intensified discussions and media coverage around consumers could have influenced their perceptions, and it is challenging to measure the extent and frequency of such exposure in a survey, an attribution error similar to the omitted variable bias might be present in previous research. Therefore, certified plant-based milk is a potentially better medium for explaining demand patterns with measurable factors, such as education level and relevant experience outlined later.

At least two studies partially covered LR II and DR by looking into dairy milk products carrying the organic, non-GMO, or both designations (dairy milk cannot be GM regardless of the nature of feed according to GE, but not NGPV, standards). Overall, price-sensitive customers were more vulnerable to dual-labeling of dairy milk (Janßen and Langen, 2017), and consumers were willing to pay $0.57 for LR II and $0.36 for DR (Ufer, Ortega and Wolf, 2021). But the researchers were not able to observe and analyze LR I in the same experiments because it does not occur independently on dairy milk products. Nonetheless, the demand for plant-based milk is fundamentally different from that for staple foods such as salt and dairy milk. As the elasticity of staple foods is

usually lower, WTP differences in absolute terms may not apply to non-essential goods like plant-based milk. Additionally, in the research conducted by Palmieri, Stefanoni, Latterini and Pari (2021), people's curiosity was deemed contributive to a higher WTP for newly launched and functional pasta. Since new brands and varieties of plant-based milk are constantly emerging, and they are often functional in terms of added nutrition or serving the dairy-restricted crowd, existing studies may not capture similar novelty effects that plant-based milk possesses. Finally, few studies, if there are any, have ever looked into the impact of trace amount disclosures on consumer WTP for USDA Organic and NGPV products.

For the reasons above, a more specific and in-depth coverage of labeling inefficiency would likely benefit researchers and manufacturers. At the current stage, this study would be the first to i) simultaneously examine the impacts of the three types of LR and the awareness about them on consumer WTP for certified plant-based milk products, and; ii) assess people's existing knowledge about CE and their updated WTP for certified products upon receipt of new information. It contributes to the literature by validating existing findings of redundant labels on the novel plant-based products and introducing a brand new perspective on studying labeling inefficiency.

HYPOTHESES

The main hypotheses are formulated as below:

H1: Consumer WTP for plant-based milk without food certifications differs from that for plant-based milk carrying the USDA Organic Seal, NGPV mark, or both.

Dairy milk products with certifications of organic or other differentiated production practices usually receive a price premium, as shown in prior research by Aizaki, Nanseki and Zhou (2012), Ding and Veeman (2019) and Yormirzoev, Li and Teuber (2020). However, there is also evidence of negligible effects (Schott and Bernard, 2015).

H2: Consumers update their preferences based on new information about LR and CE; their WTP for inefficiently labeled plant-based milk is negatively related to the amount of such information.

Many researchers have identified insufficient understandings of the meanings of USDA Organic (Abrams, Meyers and Irani, 2009; Stanton and Cook, 2019) and non-GMO certifications (Wunderlich and Gatto, 2015) among consumers, and it is a reasonable assumption that details about LR and CE are sometimes beyond their usual awareness. Bayesian updating theories state that people refresh beliefs by merging new information with existing perceptions, while weights allocated to the new information could vary. With regard to additional information provisions on certification criteria, there are mixed reports of either no statistically significant effects (Sackett, Shupp and

Tonsor, 2016; Vecchio, Van Loo and Annunziata, 2016), positive effects (Lombardi, Berni and Rocchi, 2017) or adverse effects (Streletskaya, Liaukonyte and Kaiser, 2019) on consumer WTP. When revealed, information on trace amounts allowed could also have measurable effects on consumer preferences.

H3: A higher existing knowledge level also leads to lower WTP for inefficiently labeled plant-based milk when active information provisions are absent.

Education level, relevant experience and demonstrated familiarity with the subject matter are typical estimators for existing knowledge level of participants. All of the three factors have been historically determined to be negatively associated with WTP for inefficient labels: Heng, Peterson and Li (2016) found that more educated respondents, defined as having bachelor's degrees or higher, had lower WTP for hormone-free eggs; Wilson and Lusk (2020) established a link between respondents' farm experience and their relative reluctance to pay a premium for redundant labels associated with production practices; Bernard, Duke and Albrecht (2019) illustrated that consumers who were familiar with one watermelon association tended to place less value on products carrying the association's label and another label making overlapping claims. Since this study will adopt a knowledge score taking all of the three estimators into consideration, and CE is similarly attainable knowledge, it is expected that a negative relationship between the existing knowledge level and WTP for inefficiently labeled plant-based milk will persist. By excluding the effects of the

information treatments, this hypothesis helps assess the routine grocery shopping situation where consumers rely on previously acquired knowledge, instead of immediate supplemental information, to make shelf decisions. Validating potential links between knowledge level and consumer WTP net of hypothetical information provisions would also provide insights into consumer education through a long-term reinforcement of one or more of the three factors.

PRIMARY DATA COLLECTION

The primary data of this study was collected through a Qualtrics survey[1] administered during February and March, 2022. Cornell University Institutional Review Board reviewed the research protocol and granted an exemption (see **Appendix 1**). A total of 250 participants were recruited from the research platform Prolific. The sample was constructed based on the following prescreening: living in the US for one or more years, being the primary grocery shopper in the household, and being a non-student. The first two pre-screeners ensured that all participants had either existing experience with US food certifications or the capacity to understand the meanings and functions of them during the experiment; the additional one excluding current students made sure that the elicited education level and relevant experience were accomplished instead of in-progress. Required activities, benefits, including a $2.40 payment for taking part in the 15-minute survey, and rights associated with this study were communicated through a consent form. Additionally, all participants were randomly assigned into three equally sized groups: control, criteria and full. An overview of the survey and treatment design is presented in **Appendix 2**.

The Becker-DeGroot-Marschak (BDM) mechanism (Becker, Degroot and Marschak, 1964) is commonly applied in collecting respondents' WTP. One advantage

[1] The original survey could be accessed via the following link: https://cornell.ca1.qualtrics.com/jfe/preview/SV_ba10SjLjvDFxvzU?Q_CHL=preview&Q_SurveyVersionID=current

of the BDM method is its capacity to reveal real, instead of hypothetical, WTP (Schmidt and Bijmolt, 2019) and thus alleviate the hypothetical bias. Among incentive-compatible methods, the BDM auction is also preferred for not posing direct competition among participants (Marescotti et al., 2021). Efforts were made to closely resemble the online bidding structure to that of the BDM, despite the unavailability of in-person experiments and the perishable nature of plant-based milk products. In the first part of the survey, participants were introduced to the best action to take, which was submitting bids equal to their maximum WTP, through a tutorial on bidding for a one-dollar bill. Two comprehension check questions further ensured that common misconceptions around the second-price BDM auction and first-price ones (Cason and Plott, 2012) did not exist. It turned out that 49 of those initially recruited failed twice for one or more comprehension checks and were excluded from the study, a surprising outcome compared to the ease of training the BDM as reported by Ginon et al. (2009). The conditions for purchasing a product were: 10 among the 250 participants would be randomly selected to receive an additional $10 payment, and they would be asked to purchase a random product at its random price using the bonus, if their bids for the exact item were equal to or greater than the random price. The only difference from the conventional BDM method was that purchased items would be delivered in gift cards equal to respondents' bid values instead of physical shipments.

Respondents were then asked to report their existing familiarity with the certification criteria of both USDA Organic and NGPV. After that, they were prompted to complete the following quiz for the two certifications: "based on my knowledge, [certified] products must contain 100% [qualified ingredients]". Regardless of their responses, general introductions to USDA Organic and NGPV were provided to respondents in criteria and full groups:

Figure 2: general introductions to USDA Organic and NGPV, available to criteria and full groups

Prior to answering questions about their consumption patterns, all participants reviewed a brief definition of plant-based milk in case they had limited or no experience with this specialized product category. Next, eight products were sequentially presented: soy milk with no food certifications, USDA Organic soy milk, NGPV soy milk, dual-labeled soy milk, and their oat milk counterparts. Three of the eight products

involved LR while six of them implied CE. Besides the varying combinations of labels, the products were uniformly presented as 64 fl oz (1.89 L) packs.

Table 2: occurrences of inefficient labeling on the eight products

Product	**Forms of inefficient labeling**	**Real life example(s)**
Soy milk no label	None	Yeo's
USDA Organic soy milk	CE	365 by Whole Foods Market
NGPV soy milk	CE	Silk
Dual-labeled soy milk	CE, LR I	Westsoy, Soy Dream
Oat milk no label	None	Trader Joe's, Oatly
USDA Organic oat milk	CE	RISE, Forager
NGPV oat milk	CE, LR II	Planet
Dual-labeled oat milk	CE, DR	Pacific Foods

Figure 3: sample product image (dual-labeled soy milk)

Before submitting their maximum WTP from $0 to $10 for each product presented, participants in the criteria group read paragraphs about LR applicable to the product that appeared next, and participants in the full group read information about both LR and CE. All participants were requested to enter exact dollar-and-cent amounts to avoid the inaccuracy with click-and-drag scales encountered in the previous research by Wilson and Lusk (2020).

Facts about LR and CE, including detailed types and amounts of trace ingredients permitted by the USDA and Non-GMO Project, were sourced from the entities' official websites and processed into short paragraphs. Despite the inherently negative tone of these descriptions, words like "redundant" or "exception" were avoided throughout the survey to prevent the framing effect (Tversky and Kahneman, 1981) and allow participants to absorb the information to their own judgment. The information treatments were also curated to include the inability of USDA Organic to preclude the rare case where there was an accidental presence of GM ingredients due to the absence of PCR tests, so that coexistence of the USDA Organic Seal and NGPV mark might not be completely redundant to the discretion of respondents:

Figure 4: descriptions of DR and CE, available to full group respondents immediately before bidding for dual-labeled oat milk

- The USDA Organic certification implies the certified products to be already **non-GMO in general** by ensuring that they **do not use any GMO ingredients** in the production (without a PCR test, it does not preclude the rare case where there is an *accidental presence* of GMO ingredients during production).
- There is currently **no available GMO variant** of oats. This means that the single predominant ingredient (oats) used to make oat milk is **always non-GMO**.
- USDA Organic certified products can contain the following **non-organic ingredients** up to **5% in weight or fluid volume**: products with no widely available organic versions, processing aids, and synthetic substances such as vaccines for livestock on the National List.
- Non-GMO Project Verified products can contain **trace amounts of GMO ingredients** up to **0.9% in total weight**, for example, if a producer used a fortification or preservative that accidentally contained a small amount of GMO products.

Two attention check questions were deployed across the eight bidding rounds to monitor attentiveness without significantly altering participants' behavior (Gummer, Roßmann and Silber, 2018). In these questions, participants were instructed to select particular choices, and they had to pass at least one attention check to be accepted. It helped mitigate the ambiguity surrounding unchanged WTP for multiple products, as participants could either have the same demand for the products or not pay close attention to their differences. Only one respondent failed both attention checks and was excluded from the experiment.

In the final part of the survey, personal attributes such as milk sensitivity and vegetarian status were elicited along with basic demographic information. Lastly, participants were asked to answer a policy-related question using a Likert scale: "How

do you agree with the statement that the government should require certified products to explicitly disclose trace amounts of non-organic and/or GMO ingredients on their labels?" Demographic compositions, personal characteristics and other responses are presented in **Table 3**:

Table 3: descriptive statistics of the sample and treatment groups, percentages in parentheses

	Sample	**Control**	**Criteria**	**Full**
Number of Participants	250	83	84	83
Mean WTP	3.06	3.47	2.71	2.99
Age - Mean/Median	41/39	42/41	39/37	42/39
Gender - Female	159 (63.6%)	53 (63.9%)	52 (61.9%)	54 (65.1%)
Gender - Male	87 (34.8%)	29 (34.9%)	31 (36.9%)	27 (32.5%)
Gender - Other	4 (1.6%)	1 (1.2%)	1 (1.2%)	2 (2.4%)
Ethnicity - African American	18 (7.2%)	7 (8.4%)	4 (4.8%)	7 (8.4%)
Ethnicity - Asian	11 (4.4%)	3 (3.6%)	3 (3.6%)	5 (6%)
Ethnicity - Caucasian	203 (81.2%)	65 (78.3%)	70 (83.3%)	68 (81.9%)
Ethnicity - Hispanic	8 (3.2%)	1 (1.2%)	4 (4.8%)	3 (3.6%)
Ethnicity - Other	9 (3.6%)	7 (8.4%)	2 (2.4%)	0
Household Income - $40,000 and above	175 (70%)	65 (78.3%)	53 (63.1%)	60 (72.3%)
Education - Undergraduate and above	185 (74%)	62 (74.7%)	59 (70.2%)	64 (77.1%)
Vegan status - Yes	24 (9.6%)	5 (6%)	7 (8.3%)	12 (14.5%)
Prior experience - Yes	37 (14.8%)	12 (14.5%)	13 (15.5%)	12 (14.5%)
Very familiar or somewhat familiar w/ USDA Organic criteria (self-reported)	108 (43.2%)	41 (49.4%)	28 (33.3%)	39 (47%)
Barely or not familiar at all w/ USDA Organic criteria (self-reported)	142 (56.8%)	42 (50.6%)	56 (66.7%)	44 (53%)
Correct in USDA Organic quiz	45 (18%)	17 (20.5%)	12 (14.3%)	16 (19.3%)

Unsure or wrong in USDA Organic quiz	205 (82%)	66 (79.5%)	72 (85.7%)	67 (80.7%)
Very familiar or somewhat familiar w/ NGPV criteria (self-reported)	92 (36.8%)	28 (33.7%)	34 (40.5%)	30 (36.1%)
Barely or not familiar at all w/ NGPV criteria (self-reported)	158 (63.2%)	55 (66.3%)	50 (59.5%)	53 (63.9%)
Correct in NGPV quiz	15 (6%)	6 (7.2%)	4 (4.8%)	5 (6%)
Unsure or wrong in NGPV quiz	235 (94%)	78 (94%)	80 (95.2%)	78 (94%)
Purchased certified food products - within one year	199 (79.6%)	68 (81.9%)	64 (76.2%)	67 (80.7%)
Purchased packaged plant-based milk - within one year	113 (45.2%)	37 (44.6%)	30 (35.7%)	46 (55.4%)
Indirectly consumed plant-based milk - within one year	184 (73.6%)	63 (75.9%)	62 (73.8%)	58 (69.9%)
Healthy eater - Yes	88 (35.2%)	30 (36.1%)	26 (31%)	32 (38.6%)
Habit of reading labels - Yes	203 (81.2%)	72 (86.7%)	63 (75%)	68 (81.9%)
Milk sensitivity - Yes	58 (23.2%)	11 (13.3%)	15 (17.9%)	32 (38.6%)
Policy question attitude - Highly or somewhat agree	150 (60%)	57 (68.7%)	44 (52.4%)	49 (58.3%)

DATA ANALYSIS

The Student's t-test compares whether the mean WTP of $2.94 for one baseline in the study, soy milk with no food certifications, is statistically different from the mean WTP of $3.17 for the other baseline, oat milk with no food certifications. Since the same respondent submitted bids for both baseline products, a paired t-test is performed as the observations are not expected to be independent. The t-statistic is -2.4821 with 249 degrees of freedom, and the two-tailed p-value is 0.0137. Therefore, it is concluded that the average WTP for the two baseline products is statistically different at $p = 0.05$ level, and adjustments will be made in the subsequent analysis where necessary.

The marginal effects of personal attributes and treatment group affiliations on respondents' WTP are analyzed using the Ordinary Least Square (OLS) with the robust standard error assumption at product level, with the subscript i denoting individual respondents. Among the personal attributes, $Knowledge_i$ is a converted score that comprises respondents' education levels, demonstrated familiarity with the two certifications in the quiz questions, and prior experience with food science, nutrition or labeling. Each factor equally contributes to the total $Knowledge_i$ score up to one, and participants' levels of achievements determine the factor scores. For example, a person who answered both quiz questions with "No", had a bachelor's degree and had attended a food science seminar held a knowledge score of 0.89 (⅓ + ⅔ × ⅓ + ⅓); a

person who answered one quiz question with “No", had a master’s degree and had not attended any related course or information session held a knowledge score of 0.44. The constant term in this model is α, and marginal effects of personal attributes and treatment group affiliations are estimated by their corresponding β values:

$$WTP_i = \alpha + \beta_{Age}Age_i + \beta_{Gender}Gender_i + \beta_{Income}Income_i + \beta_{Knowledge}Knowledge_i + \beta_{Vegan}Vegan_i + \beta_{Sensitivity}Sensitivity_i + \beta_{Treatment}Treatment_i + \varepsilon_i$$

Table 4: WTP for individual plant-based milk product with personal explanatory variables, robust standard errors, 3 significant figures, standard errors in parentheses

Product	Constant	Age	Gender - Male	Gender - Other	Income	Knowledge Score	Vegan - Yes	Milk Sensitivity - Yes	Criteria Treatment	Full Treatment
Soy milk no label	**2.695***** (0.576)	-0.010 (0.010)	**0.563**** (0.260)	**2.183***** (0.530)	**0.179**** (0.091)	-0.757 (0.652)	0.198 (0.417)	**0.521*** (0.274)	**-0.686**** (0.302)	-0.469 (0.317)
USDA Organic soy milk	**3.391***** (0.619)	-0.011 (0.011)	**0.516*** (0.285)	**1.947***** (0.558)	**0.211*** (0.108)	-1.001 (0.742)	0.406 (0.498)	0.476 (0.290)	**-0.746**** (0.337)	**-0.579*** (0.350)
NGPV soy milk	**3.500***** (0.617)	-0.013 (0.011)	0.390 (0.293)	**1.880***** (0.106)	**0.180*** (0.106)	**-1.214*** (0.730)	0.514 (0.498)	0.319 (0.299)	**-0.729**** (0.341)	-0.343 (0.353)
Soy milk dual-labeled	**3.933***** (0.649)	-0.018 (0.012)	0.489 (0.303)	**1.729***** (0.588)	**0.215*** (0.114)	**-1.316*** (0.795)	0.476 (0.496)	**0.573*** (0.309)	**-0.742**** (0.351)	-0.528 (0.373)
Oat milk no label	**3.171***** (0.547)	**-0.017*** (0.009)	**0.403*** (0.240)	**1.776**** (0.804)	**0.223***** (0.084)	-0.154 (0.705)	0.602 (0.395)	0.144 (0.255)	**-0.894***** (0.298)	**-0.667**** (0.294)
USDA Organic oat milk	**3.888***** (0.559)	**-0.021**** (0.010)	0.224 (0.256)	**1.404**** (0.675)	**0.260***** (0.093)	-0.292 (0.742)	0.747 (0.464)	0.211 (0.286)	**-0.804**** (0.313)	**-0.680**** (0.317)
NGPV oat milk	**4.075***** (0.566)	**-0.023**** (0.010)	0.177 (0.265)	**1.475**** (0.670)	**0.255***** (0.094)	-0.609 (0.720)	**0.891*** (0.487)	0.024 (0.287)	**-0.961***** (0.317)	**-0.679**** (0.314)
Oat milk dual-labeled	**4.777***** (0.594)	**-0.026***** (0.010)	0.116 (0.276)	**1.040*** (0.628)	**0.209**** (0.099)	-0.710 (0.765)	**1.049**** (0.471)	0.112 (0.300)	**-1.064***** (0.329)	**-0.791**** (0.333)

Baseline: female, non-vegan and non-vegetarian, not sensitive to dairy milk, control group
*** $P \leq 0.01$; ** $P \leq 0.05$; * $P \leq 0.1$

The WTP results are then pooled into two n = 1,000 (4 × 250) samples[2] for each product type without controlling socioeconomic factors. The OLS regression with clustered standard error at the respondent level is adopted to estimate the marginal effects of another set of control variables of interest. Here, the subscript *i* indicates the subject and *j* denotes the product present. For the soy milk sample, the constant term in the regression is α; $Knowledge_i$ is the converted score derived earlier; $Treatment_i$ is a dummy variable for the three possible group assignments; binary variable $Organic_j$ equals one if the USDA Organic Seal is present, and binary variable $NGPV_j$ equals one if the NGPV mark is present. The first interaction term $Organic_j \times NGPV_j$ represents the presence of LR I, and the second interaction term $Treatment_i \times Organic_j$ represents the treatment effect conditional on the presence of the USDA Organic Seal. Similarly, $Treatment_i \times NGPV_j$ represents the treatment effect conditional on the presence of the NGPV mark, and the three-way interaction term $Treatment_i \times Organic_j \times NGPV_j$ represents the treatment effect conditional on the presence of LR I.

For the oat milk sample, the binary variable $NGPV_j$ equivalently signals if LR II is present, and $Organic_j \times NGPV_j$ represents the presence of DR instead of LR I alone. Likewise, the three-way interaction term $Treatment_i \times Organic_j \times NGPV_j$ represents the treatment effect conditional on the presence of DR. Each β value reflects the marginal effect of the respective independent variable:

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[2] The WTP results are not pooled into a single sample with 2,000 observations because denoting treatment effects on different types of LR would require four-way interactions, which are often complex to interpret.

$$WTP_{ij} = \alpha + \beta_1 Knowledge_i + \beta_2 Treatment_i + \beta_3 Organic_j + \beta_4 NGPV_j + \beta_5 (Organic_j \times NGPV_j) + \beta_6 (Treatment_i \times Organic_j) + \beta_7 (Treatment_i \times NGPV_j) + \beta_8 (Treatment_i \times Organic_j \times NGPV_j) + \varepsilon_{ij}$$

Table 5: WTP for soy milk, pooled OLS model, clustered standard error at individual level, 3 significant figures, robust standard errors in parentheses, observation = 1,000

Constant	**3.027***** (0.347)	Criteria × USDA Organic	-0.054 (0.122)
Knowledge	-0.849 (0.718)	Full × USDA Organic	-0.110 (0.131)
Criteria	**-0.643**** (0.308)	Criteria × NGPV	-0.031 (0.143)
Full	-0.332 (0.324)	Full × NGPV	0.102 (0.154)
USDA Organic	**0.659***** (0.082)	Criteria × USDA Organic × NGPV	0.066 (0.155)
NGPV	**0.496***** (0.097)	Full × USDA Organic × NGPV	-0.022 (0.153)
USDA Organic × NGPV	**-0.318***** (0.103)		

Baseline: soy milk no label, control group
*** P ≤ 0.01; ** P ≤ 0.05; P ≤ 0.1

Table 6: WTP for oat milk, pooled OLS model, clustered standard error at individual level, 3 significant figures, robust standard errors in parentheses, observation = 1,000

Constant	**3.215***** (0.332)	Criteria × USDA Organic	0.102 (0.130)
Knowledge	-0.172 (0.707)	Full × USDA Organic	0.011 (0.120)
Criteria	**-0.847***** (0.301)	Criteria × NGPV	-0.049 (0.135)
Full	**-0.599**** (0.297)	Full × NGPV	-0.020 (0.137)
USDA Organic	**0.543***** (0.070)	Criteria × USDA Organic × NGPV	-0.180 (0.137)

NGPV	**0.529***** (0.078)	Full × USDA Organic × NGPV	-0.084 (0.124)
USDA Organic × NGPV	**-0.144**** (0.071)		

Baseline: oat milk no label, control group
*** P ≤ 0.01; ** P ≤ 0.05; * P ≤ 0.1

Since respondents were required to submit bids between $0 and $10 in the experiment, it is a common practice (Bernard, Duke and Albrecht, 2019; Streletskaya, Liaukonyte and Kaiser, 2019; Rihn, Khachatryan and Wei, 2021) to evaluate the pooled WTP results using the Tobit model, in where left and right-censoring of the dependent variable are given due considerations when estimating the linear relationships. A total of 338 zero bids and 12 ten-dollar bids were collected, confirming that censoring from both above and below is active in this study:

Figure 5: Histogram of bid frequency distribution for soy milk (with normal density curve and highlighted two-side limits)

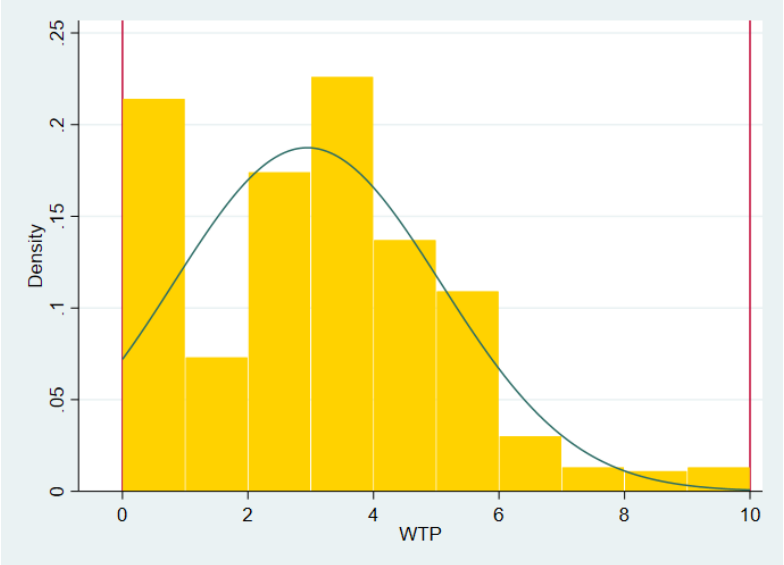
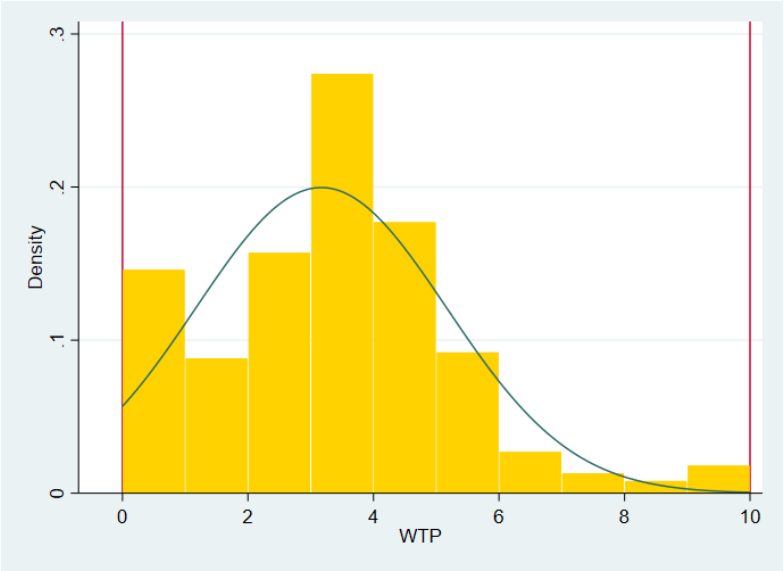


Figure 6: Histogram of bid frequency distribution for oat milk (with normal density curve and highlighted two-side limits)



The Tobit regression makes it possible to look at WTP_{ij}*, the true value of WTP_{ijt} as if there were no bidding limits in place. The latent variable WTP_{ij}* is modeled as:

$$WTP_{ij}^* = X\beta + \varepsilon_{ij}$$

$$WTP_{ij} = max\ (WTP^*_{ij},\ 0)\ if\ WTP^*_{ij} < 10$$

$$WTP_{ij} = 10\ if\ WTP^*_{ij} > 10$$

with X being the same vector of independent variables specified in the pooled OLS model, β being the vector of coefficients and ε_{ij} being the normally distributed error term with a zero mean. The latent variable is directly observable for submitted bids between \$0 and \$10.

Table 7: WTP for soy milk, Tobit model with upper limit of 10 and lower limit of 0, clustered standard error at individual level, 3 significant figures, robust standard errors in parentheses, observation = 1,000

Constant	**2.796***** (0.425)	Criteria × USDA Organic	-0.002 (0.153)
Knowledge	-1.033 (0.926)	Full × USDA Organic	-0.105 (0.168)
Criteria	**-0.741*** (0.401)	Criteria × NGPV	0.019 (0.195)
Full	-0.402 (0.418)	Full × NGPV	0.194 (0.206)
USDA Organic	**0.742***** (0.097)	Criteria × USDA Organic × NGPV	0.033 (0.214)
NGPV	**0.542***** (0.127)	Full × USDA Organic × NGPV	-0.063 (0.202)
USDA Organic × NGPV	**-0.373***** (0.135)		

Baseline: soy milk no label, control group
*** P ≤ 0.01; ** P ≤ 0.05; * P ≤ 0.1

Table 8: WTP for oat milk, Tobit model with upper limit of 10 and lower limit of 0, clustered standard error at individual level, 3 significant figures, robust standard errors in parentheses, observation = 1,000

Constant	**3.095***** (0.367)	Criteria × USDA Organic	0.184 (0.160)
Knowledge	-0.112 (0.802)	Full × USDA Organic	0.034 (0.137)
Criteria	**-0.984***** (0.353)	Criteria × NGPV	0.014 (0.170)
Full	**-0.701**** (0.347)	Full × NGPV	0.039 (0.163)
USDA Organic	**0.563***** (0.073)	Criteria × USDA Organic × NGPV	-0.258 (0.171)
NGPV	**0.538***** (0.086)	Full × USDA Organic × NGPV	-0.117 (0.144)
USDA Organic × NGPV	**-0.148*** (0.080)		

Baseline: oat milk no label, control group
*** P ≤ 0.01; ** P ≤ 0.05; * P ≤ 0.1

Combining the heavy censoring from below as shown in **Figures 5-6** and the standard interpretation of zero bids as unwillingness to buy, further analysis needs to be conducted in order to understand what factors contribute to the respondents' likelihood of adopting plant-based milk products (i.e., having positive WTP of any amount for the product presented). The logistic regression is suitable for this purpose: the dependent variable *WTP* can be converted into a binary variable *PURCHASE* that equals one if *WTP* is greater than zero and equals zero if *WTP* equals zero. For this part of the analysis, WTP results are merged into a comprehensive n = 2,000 sample. $Treatment_i$ and relevant terms are dropped since zero bids spread fairly evenly across the three groups (100 for the control group, 121 for the criteria group and 117 for the full group). Instead, personal attributes used in the product-level OLS model along with a binary variable of Oat_j are added to the set of independent variables to recognize the statistically significant baseline difference. The likelihood ratio chi-square for this logistic model is 0.0000, indicating that the estimation fits significantly better than a model with no predictors at p = 0.01 level. Except for the gender of "others" and a total of 32 relevant observations dropped due to perfect predictions, coefficients in the logistic regression model are reported below:

Table 9: likelihood of adopting plant-based milk, logistic model, 3 significant figures, standard errors in parentheses, observation = 1,968

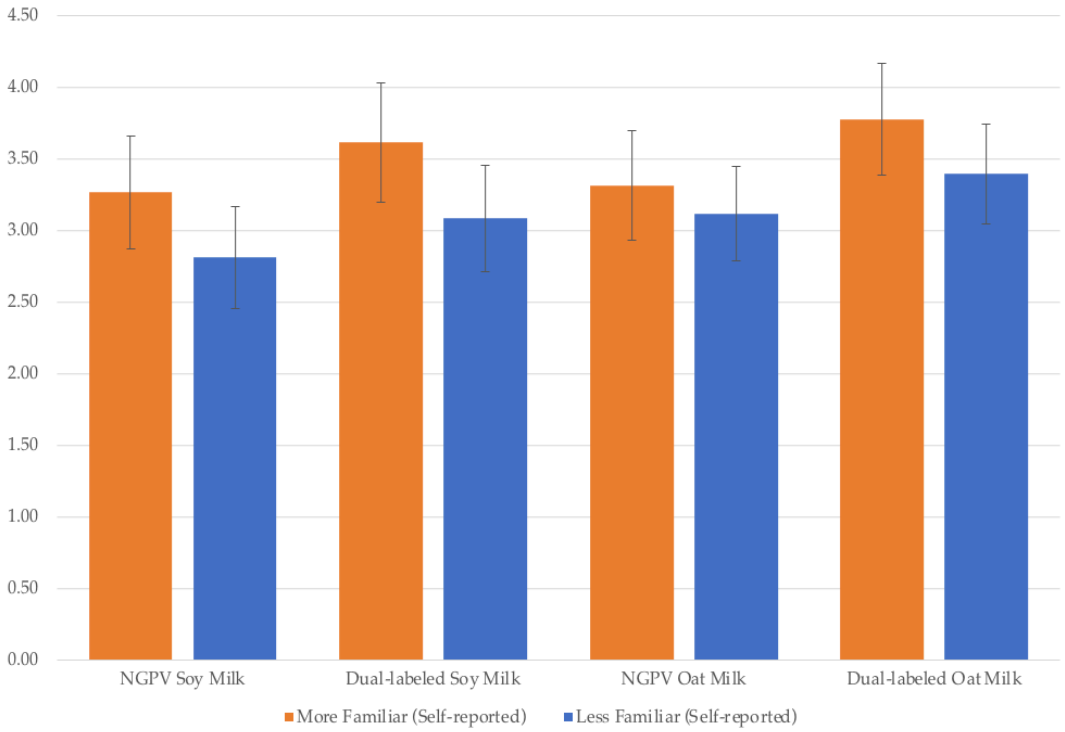
Constant	**1.674***** (0.274)	Vegan - Yes	0.107 (0.215)
Oat	**0.469***** (0.122)	Milk Sensitivity - Yes	0.150 (0.148)
Knowledge	-0.115 (0.340)	USDA Organic	**0.307*** (0.168)
Age	**-0.021***** (0.005)	NGPV	**0.277*** (0.167)
Gender - Male	0.096 (0.129)	USDA Organic × NGPV	-0.245 (0.243)
Income	**0.133**** (0.054)		

Baseline: female, soy milk no label, non-vegan and non-vegetarian, not sensitive to dairy milk
*** P ≤ 0.01; ** P ≤ 0.05; * P ≤ 0.1

RESULTS AND FINDINGS

In the knowledge test of whether certified products must contain 100% qualified ingredients, only 18% of participants answered correctly for USDA Organic and only 6% answered correctly for NGPV. This is in spite of the fact that around 40% of the respondents identified themselves as at least somewhat familiar with certification criteria and a vast majority (over 80%) of them had the habit of reading labels on food and drink products. The strongest misconception existed among the 92 respondents who first self-reported as at least somewhat familiar with NGPV certification criteria: nearly 97% of them turned out to be wrong or unsure about the composition threshold compared to 93% of the other 158 respondents who admitted to being barely or not familiar with NGPV at all. Such bias was absent for USDA Organic: a higher proportion of respondents who self-reported as at least somewhat familiar with USDA Organic criteria indeed answered correctly in the quiz about the content level of organic ingredients. Furthermore, these 92 respondents exhibited higher WTP for all forms of NGPV presence than their "less knowledgeable" peers on average:

Figure 7: WTP for products carrying NGPV marks by self-reported familiarity with NGPV criteria, 95% confidence intervals



Note that the actual level of awareness might be even lower than observed, as participants had access to external resources when answering the quiz in the unmonitored online survey environment.

Table 4 supplies remarkable insights regarding the effects of certification labels on consumer WTP net of other influences within the control group. For instance, single presence of the NGPV mark is associated with higher WTP than USDA Organic Seal, as evident by the constants of 3.500 versus 3.391 for soy milk and 4.075 versus 3.888 for oat milk. Dual-labeled products also received the highest WTP within their type, though the increased WTP attributable to label coexistence is lower than the sum of individual

effects. Among personal attributes, age is a significant factor influencing respondents' demand for oat milk, as respondents being one year older tended to pay about 2 cents more; male respondents tended to pay more for plant-based milk, though statistical significance only exists for soy milk with no certifications, USDA Organic soy milk and oat milk with no certifications; respondents with gender declared as "other" also tended to pay a positive and statistically significant price premium; income cast consistently positive and significant impacts on WTP, as a one-level increase in household income would increase respondents' WTP for plant-based milk of all kinds by amounts between $0.18 and $0.26, ceteris paribus.

On the other hand, respondents' knowledge score negatively correlates with their WTP for plant-based milk products, and such negative correlation is stronger for products with LR and CE, confirming that acquired knowledge caused respondents to bid less only for relevant products. Interesting substitution effects are spotted among vegan or vegetarian respondents and respondents with milk-related sensitivities: both types of respondents were willing to pay a higher amount for all kinds of plant-based milk compared to their peers, which was reasonably expected given their inability to consume conventional cow milk; however, vegan or vegetarian respondents seemed to prefer oat milk as a substitute, whereas respondents with milk-related sensitivities placed higher WTP for soy milk. Lastly, participants in the criteria group exhibited lower WTP by the amount of $0.69 to $1.06 depending on the product type compared to

control group participants, and this result is statistically significant; full treatment is less negatively correlated with WTP, a statistically significant result except for soy milk with no certifications, NPGV soy milk and dual-labeled soy milk.

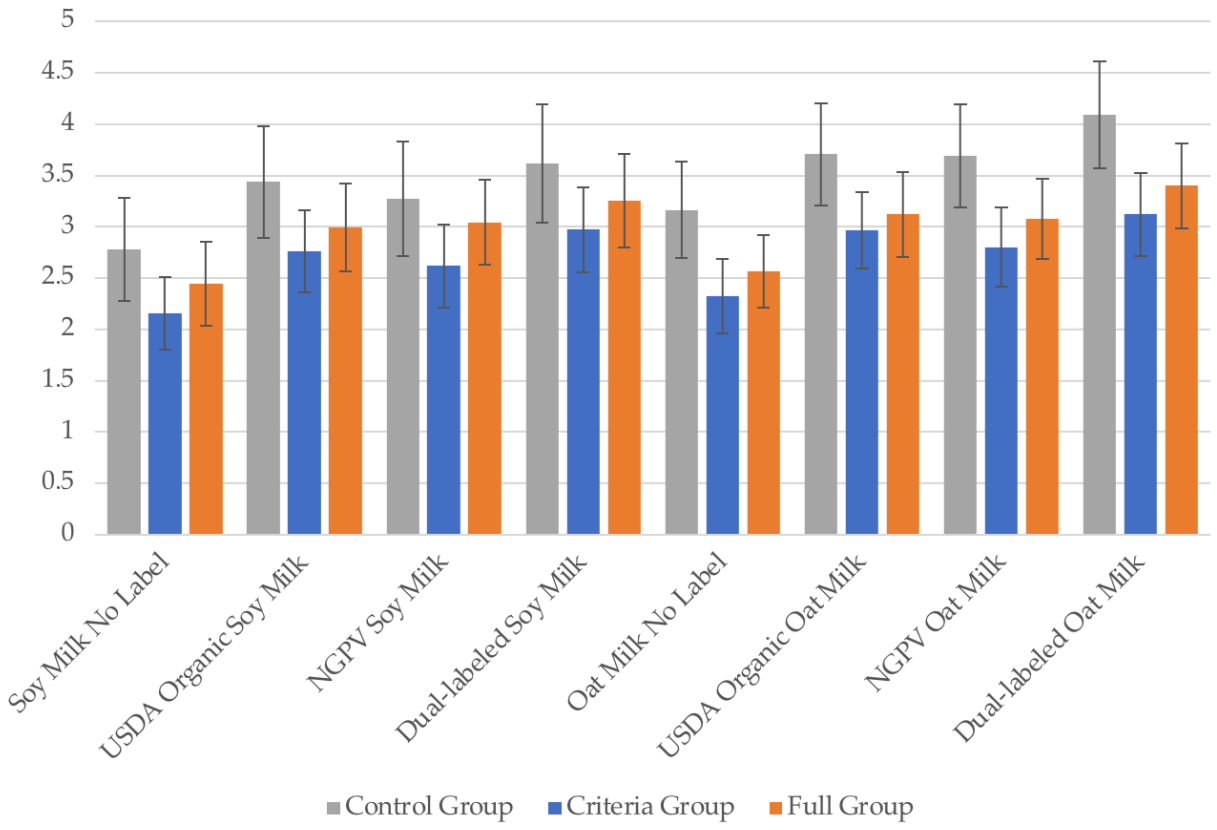
When comparing the results in **Table 5** and **Table 7**, the constant term, criteria treatment, presence of the USDA Organic Seal and NGPV mark, plus the coexistence of the two certifications are significant factors related to consumer WTP for soy milk in both the OLS and Tobit models. Tobit estimations lead to a decrease in the significance of criteria treatment and greater marginal effects of the significant factors except for the constant term. Based on the Tobit results, participants in the control group were willing to pay $2.80 for soy milk with no food certification labels. Both information treatments were associated with lower WTP, with criteria group participants paying $0.74 less and full group participants paying $0.40 less on average. The less negative and less significant effect of full treatment is consistent with what has been found in the product-level OLS model. Presence of the USDA Organic Seal and the NGPV mark increased consumer WTP by $0.74 and $0.54, respectively. The only statistically significant interaction term is USDA Organic × NGPV, and the negative coefficient indicates a "penalty" for attaching both certifications. Participants were willing to pay a premium of $0.91 ($0.74 + $0.54 - $0.37) for dual-labeled soy milk, which translates to a premium of $0.17 ($0.91 - $0.74) for LR I, or the redundant NGPV mark. An increased knowledge level led to reduced WTP for soy milk, though the coefficient of -1.033 is not significant.

In the Tobit estimations for oat milk in **Table 8**, full treatment also becomes a significant factor in determining consumer WTP. In average terms: control group participants were willing to pay $3.10 for oat milk with no food certifications; criteria treatment reduced WTP by $0.98; full treatment reduced WTP by $0.70; presence of the USDA Organic Seal increased WTP by $0.56; presence of the redundant NGPV mark increased WTP by $0.54; and coexistence of both certifications entails the highest price premium of $0.95 ($0.56 + $0.54 - $0.15), with the portion attributable to DR being $0.39 ($0.95 - $0.56).

Turning to the question of whether participants would adopt plant-based milk products at all, it is found in **Table 9** that the product type of oat milk, age, income and single presence of either the USDA Organic Seal or the NGPV mark were the only five significant motives: when holding other variables at their means, the increased probability of nonzero WTP was 6.5% for the product being oat milk rather than soy milk, 1.8% for respondents with one-level higher income, 2.5% for the presence of the USDA Organic Seal, and 2.1% for the presence of the NGPV mark. Meanwhile, being one year older was associated with a decreased probability of nonzero WTP by 0.3%. Other factors such as dual-labeling or the knowledge score would not effectively stimulate a respondent to alter non-purchasing decisions, though they might otherwise influence positive bid amounts.

Figure 8 below shows that the control group exhibited higher average WTP for all eight products than criteria and full groups:

Figure 8: average WTP by treatment groups, 95% confidence intervals

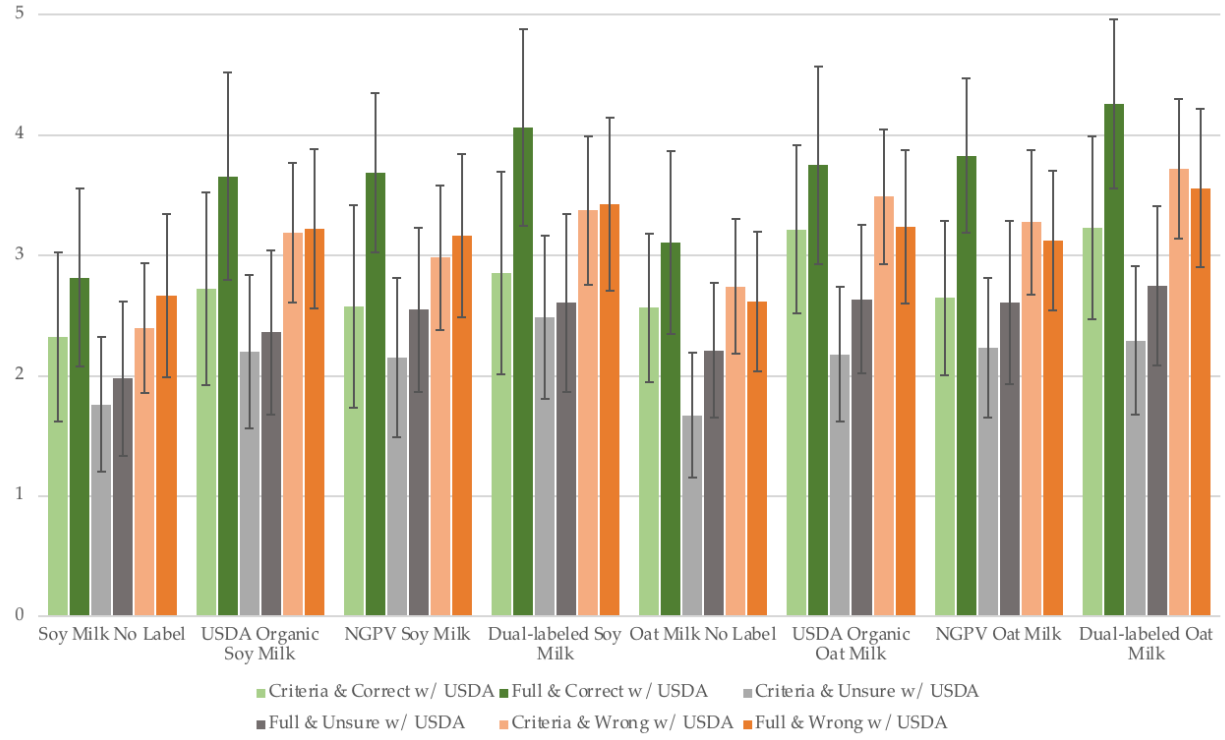


However, the criteria group unexpectedly exhibited consistently lower WTP than the full group, who accessed extra information regarding trace amounts allowed in certified products. For instance, the criteria group reported an average WTP of $2.62 for soy milk carrying a single NGPV mark while the full group reported $3.04, despite the

full group was advised that trace amounts of GM ingredients may be present in NGPV products. This intriguing trend echoes the significant but less negative coefficients of full treatment in **Table 4**, **Table 6** and **Table 8**.

To gauge people's perceived amount of qualified ingredients in certified products, respondents from criteria and full groups are sorted based on their responses in the knowledge quiz. The results are reported in the following figure:

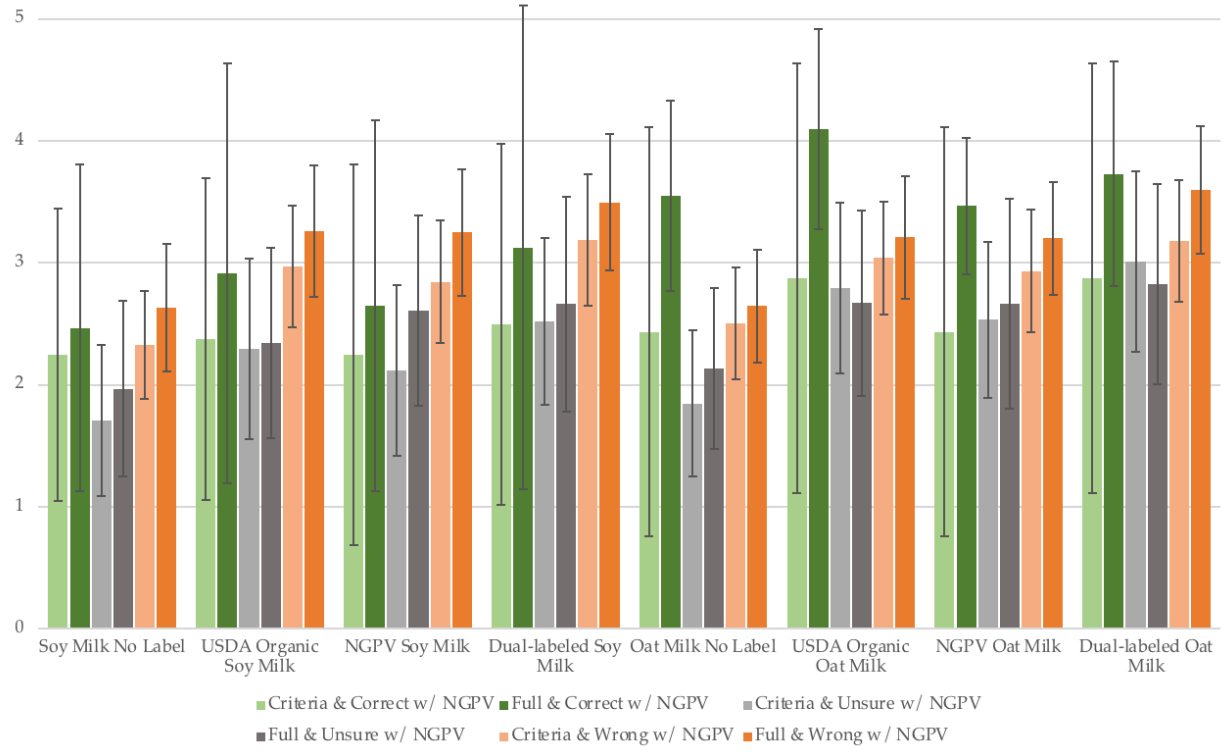
Figure 9: average WTP by treatment groups and USDA Organic knowledge quiz responses, 95% confidence intervals



For participants who answered correctly or were unsure about the USDA Organic composition threshold, bids were consistently higher in the full group. Participants who answered incorrectly about USDA Organic criteria (those who firmly believed that USDA Organic products must contain 100% organic ingredients) exhibited mixed behaviors between the two groups. For example, WTP for USDA Organic oat milk and dual-labeled oat milk was lower in the full group, while such trend no longer existed for USDA Organic soy milk or dual-labeled soy milk.

This categorization is then repeated for NGPV:

Figure 10: average WTP by treatment groups and NGPV knowledge quiz responses, 95% confidence intervals



In **Figure 10**, full group participants who answered correctly or were unsure in the NGPV quiz similarly reported higher WTP for all relevant products than their criteria group peers, with the sole exception of dual-labeled oat milk. Interestingly, full group participants who answered incorrectly in the quiz and believed that NGPV products must contain 100% non-GMO ingredients reported strictly higher, instead of merely sticky, WTP than their criteria group counterparts.

DISCUSSION

The low awareness of the actual certification criteria highlights the possibility of a consumer being tempted by the certification claims and making purchasing decisions after incorrectly interpreting the labels. The enlarged cognitive gap among those who self-reported as being more familiar with NGPV certification criteria is largely in accordance with a previous study conducted by Fernbach et al. (2019) regarding the negative correlation between aversion to GMO products and familiarity with GM facts: the 92 respondents who thought they knew more about NGPV certification criteria indeed knew less, and they were willing to pay more for the presence of NGPV mark. Price premiums attributable to misinformation about LR are supported by the statistically significant WTP differences between control and criteria groups.

The result that the control group placed higher WTP for all of the products than both the criteria and full groups is consistent with the previous study on organic wines and wines made from organic grapes (Streletskaya, Liaukonyte and Kaiser, 2019), in where respondents exposed to information about labeling requirements exhibited lower WTP attributable to cognitive loads and search costs. One complication is that messages pointing out LR and potential trace amounts might be perceived as less favorable than the relatively neutral-to-positive paragraphs used in the wine study. Therefore, lower WTP by the criteria and full groups theoretically derived from the cognitive load and

search cost, plus an extra downward pressure originated from the nature of the information treatments.

However, the slight rebound in the full group's average WTP urges a more thorough assessment of the overall impact by information about CE. Apart from the burdens and sentiments it conveys, information on trace amounts allowable could have ultimately raised consumer WTP by negating people's misperceptions of an overly low content level of qualified ingredients in USDA Organic and NGPV products. In other words, paragraphs about the allowable trace amounts (5% and 0.9%) effectively pointed out the minimum levels of qualified ingredients (95% and 99.1%) higher than participants' former beliefs and served as quality assurances for the certification marks. A supplemental fact helping explain the higher WTP for NGPV and dual-labeled oat milk by the full group is that mentioning GMO additives restored some relevancy of the NGPV mark (i.e., though the single predominant ingredient of oat could not be genetically modified, an additional line of defense against GMOs in minor ingredients made dual-labeled products appealing and LR II or DR less concerning). Similarly, the full group demonstrated higher WTP for dual-labeled soy milk presumably because they learned that NGPV implemented a stricter and more precise rule against GM materials compared to USDA, making LR I less important. Lastly, more respondents (38.6%) in the full group had milk-related sensitivities (lactose intolerance and milk allergy, etc.) compared to the criteria group (17.9%) or the sample as a whole (23.2%).

There is a possibility that more full group respondents were inclined to plant-based milk simply because of their inability to consume dairy milk and hence contributed to an inflated average WTP. As sensitivities to soy or oat were not elicited in the experiment, however, no causal link between this personal attribute imbalance and higher group average WTP could be further established.

Summarizing the Tobit results in **Tables 7-8**, a diminishing marginal return for attaching both labels is once again confirmed by the negative coefficients of USDA Organic × NGPV. For single labeled products and from the whole sample perspective, the USDA Organic Seal was a more attractive option than NGPV mark in terms of price premiums generated. This is well anticipated, as the USDA Organic Seal generally provides a wider range of implications and assurances. On average, participants were willing to pay $0.17 for LR I, $0.54 for LR II and $0.39 for DR. None of the interaction terms between treatment groups and specific certifications are statistically significant, suggesting that participants might encounter difficulties with matching the information with relevant products, and information provisions might cause a spillover effect.

Figure 9 provides valuable insights into people's perceived amount of qualified ingredients in certified organic products. Respondents who appeared to be informed about potential non-organic ingredients in USDA Organic products were, in fact, unaware or uncertain about the 5% threshold; instead, they most likely underestimated the level of qualified content in USDA Organic products. Such respondents in the full

group might have learned the maximum non-organic ingredients allowed, employed backward reasoning and bid higher. Similarly, respondents who were unsure about the answer could have assumed low organic contents, and those in the full group were able to realize their underestimation of the rigidness of USDA Organic criteria and increase their demand. Putting full group respondents as the more informed version of the criteria group respondents, those who were wrong, rather than correct or unsure, with the USDA Organic quiz question exhibited the least updating to new information (i.e., most sticky WTP): respondents who initially overestimated the content level of organic ingredients only made downward adjustments to USDA Organic oat milk and dual-labeled oat milk. This finding contradicts the one in the non-GMO sea salt study that people with less objective knowledge about labels were also less likely to exhibit static WTP after reading additional information (Wilson and Lusk, 2020), but it does align with another claim that people with stronger established beliefs tend to discredit unfavorable information and not to deviate from their current status of mind (Stuart, Schroder, Hughes and Bower, 2004; McFadden and Lusk, 2015).

Figure 10 reveals similar patterns regarding the before-experiment perceptions of the NGPV threshold: participants who answered "No" and "Not Sure" in the NGPV quiz could have underestimated the rigorousness of NGPV standards, and those in the full group adjusted WTP upwards after learning the 0.9% threshold. However, instead of mere reluctance to update WTP as reflected in **Figure 9**, full group respondents who

mistakenly believed that NGPV products must be GMO-free exhibited an abnormally higher WTP despite the direct clarifications they received. In fact, opposite reactions after providing participants with information stimulating lower bids have been frequently observed in the past (Gifford and Bernard, 2010; Heng, Peterson and Li, 2016; Wilson and Lusk, 2020). One study attempted to reconcile the discrepancy using behavioral and psychological theories including misinterpretation and illusionary correlation (McFadden and Lusk, 2015). These theories may serve as an appropriate way to address this anomaly, since such a rebound in WTP can be interpreted as sentimental or reactionary.

Finally, the initial hypotheses are revisited:

H1: Consumer WTP for plant-based milk without food certifications differs from that for plant-based milk carrying either the USDA Organic Seal, NGPV mark, or both.

The mean WTP for the three certified soy milk products is compared to that for soy milk with no food certifications using the paired Student's t-tests, and the same approach is repeated for oat milk to examine if the WTP differences are significant. It turns out that the mean WTP for all certified soy and oat milk is higher than the one for their baseline products, and all the six paired t-tests return a two-tailed p-value of 0.0000. Therefore, *H1* cannot be rejected and it is concluded that consumer WTP for plant-based milk without food certifications is both statistically different and lower than that for plant-based milk carrying either the USDA Organic Seal, NGPV mark, or both.

H2: Consumers update their preferences based on new information about LR and CE; their WTP for inefficiently labeled plant-based milk is negatively related to the amount of such information.

Based on the results in **Tables 5-8**, both information treatments negatively affected consumer WTP, and preference updating based on new information did exist. Assuming the random group assignment properly compensated the effects from existing knowledge and *H2* was valid, a strictly decreasing pattern from control to criteria to full groups regarding WTP would be observed. However, the full group is found to have higher WTP than the criteria group despite being informed about allowable trace amounts. Due to the lack of statistical significance, the mean WTP for the six certified products presented in this study has been further inspected in **Figure 8**. These results jointly prove that the additional information about CE positively affected WTP. Although explanations of this paradox have been extensively discussed, *H2* must be rejected.

H3: A higher existing knowledge level also leads to lower WTP for inefficiently labeled plant-based milk when active information provisions are absent.

H3 is validated by observing if higher knowledge scores are associated with lower WTP for certified products within the control group. Higher knowledge scores are defined as scores equal to or higher than the control group median of 0.22:

Table 10: WTP for plant-based milk within the control group by knowledge level, rows of inefficient labeled product highlighted (dark gray if both LR and CE are both present), 3 significant figures, standard errors in parentheses

Product	More knowledgeable control participants	Less knowledgeable control participants	Bid difference
Soy milk no label	2.571 (2.060)	3.315 (2.738)	0.744
USDA Organic soy milk	3.161 (2.359)	4.156 (2.721)	0.995
NGPV soy milk	2.961 (2.423)	4.089 (2.707)	1.128
Dual-labeled soy milk	3.290 (2.567)	4.463 (2.689)	1.173
Oat milk no label	3.017 (1.978)	3.548 (2.549)	0.531
USDA Organic oat milk	3.549 (2.163)	4.117 (2.507)	0.568
NGPV oat milk	3.521 (2.171)	4.143 (2.605)	0.622
Dual-labeled oat milk	3.896 (2.231)	4.604 (2.702)	0.708

Examining the results in **Table 10**, bid differences for inefficiently labeled products are larger than their baselines, and they are the largest within each product type if both forms of inefficient labeling are present. Therefore, it is reasonable to conclude that a higher existing knowledge level leads to lower WTP for inefficiently labeled plant-based milk when active information provisions are absent, and hence *H3* cannot be rejected.

CONCLUSIONS

This study evaluates the demand for products bearing different forms of inefficient labeling under several information treatments. It first defines labeling redundancy (LR) and implicitly communicated certification exceptions (CE), and proceeds to collect consumer WTP for hypothetical plant-based milk products through an innovative incentive-compatible online survey on 250 human participants.

This study confirms that the effects of LR are present on plant-based milk, a non-staple and novel consumer good. It is estimated that consumers were willing to pay $0.17 for LR I (NGPV mark on USDA Organic products made with ingredients that have GM versions), $0.54 for LR II (NGPV mark on products made with ingredients that do not have GM versions) and $0.39 for DR (NGPV mark on USDA Organic products made with ingredients that do not have GM versions). The study also finds that consumer demand was updated based on the information about the presence of LR: an average participant in the criteria group paid $0.74 less for soy milk and $0.98 less for oat milk compared to their control group peers by reading paragraphs about the facts behind certification criteria. Nevertheless, impacts of such information provisions seem to spread over all the products in the experiment instead of being precisely matched to relevant products only.

Among the personal attributes, genders of male and "other", along with the household income, were positively correlated with WTP for plant-based milk. Participants' knowledge score consisting of education level, demonstrated familiarity with the two certifications and prior experience with food science or labeling was negatively correlated with WTP. Participants with milk-related sensitivities such as lactose intolerance appeared to favor soy milk over oat milk, while vegan or vegetarian respondents placed higher WTP for oat milk.

Regarding the individual and combined effects of the two certifications on WTP, the NGPV mark was more attractive than USDA Organic Seal for the control group, but the pattern reverses when looking at the whole sample. On average, consumers were willing to pay a price premium of $0.56 to $0.74 for the single presence of the USDA Organic Seal depending on the type of milk, and $0.54 for the NGPV mark. Coexistence of the two certifications entailed the highest price premium, but it is shown to be less than the outright sum of individual effects by amounts from $0.15 to $0.37. This implies a diminishing marginal return instead of any synergy for participating in more than one certification.

Factors potentially pushing consumers to deviate from non-purchasing decisions are analyzed. In the logistic model, the product type of oat, age, income and single presence of either the USDA Organic Seal or NGPV mark were the five significant

stimuli attracting people to opt-in. In contrast, coexistence of both labels and existing knowledge were not key factors.

People's existing knowledge about if certified products must contain 100% qualified ingredients was tested via two quiz questions. It turns out that only 18% of participants answered correctly for USDA Organic and only 6% answered correctly for NGPV. Still, the general public may be more adequately informed about USDA Organic than NGPV up to this date, since respondents who self-reported as at least somewhat familiar with NGPV certification criteria displayed stronger misconceptions than the sample average in terms of a higher proportion of wrong quiz answers and higher WTP for the NGPV mark, while such bias was not observed on USDA Organic.

Even with a low level of awareness of detailed certification criteria, certifying entities and manufacturers may still hesitate to educate consumers about the actual composition threshold for qualified ingredients or any exceptions permitted extensively. Their concerns are understandable, as these facts could undermine the perceived rigorousness of the certifications and hence harm their market performance. This study starts with a similar assumption that providing participants with information about CE surrounding certified plant-based milk would reduce their WTP. However, it turns out that such information actually increased consumer WTP, conditional on backgrounds of LR also provided. Some possible explanations, including cognitive burdens, quality assurances, restored relevancy and demographic imbalance, are proposed in this study.

In the follow-up investigation of people's perceived amount of qualified ingredients in certified products, evidence of a prevailing underestimation of the content level of organic and non-GMO ingredients in USDA Organic and NGPV products is found.

The above conclusions could boil down to several managerial and marketing implications for firms. First, plant-based milk manufacturers should analyze some key parameters regarding consumer composition, such as average age, household income and vegetarian diet, in current and emerging markets to better forecast demand, if they maintain both soy and oat product lines. Second, firms could be potentially better-off by seeking USDA Organic certification first, if the two programs have comparable costs and are mutually exclusive for some reasons, as the USDA Organic Seal entails a higher price premium. They should also conduct careful cost-benefit analysis before participating in more than one certification because of the diminishing marginal return identified in this study. Third, for manufacturers wishing to attract new subscribers to soy milk and oat milk, they could refer to the significant factors in the logistic model and make appropriate marketing decisions. Finally, a disclaimer about potential trace ingredients could be lucrative through correcting consumers' misperceptions and raising WTP, as long as a numeric threshold is present.

This study comes with several limitations. First, variable *Knowledge* is constructed upon simple assumptions, such as equal weights and linear relationships. This may have contributed to its negative but statistically insignificant coefficients in the

regression outputs. Second, this study does not include a third treatment group, which could have been exposed to information about CE only. Therefore, conclusions about the positive outcome of actively disclosing trace ingredients may not hold if information about LR was not provided concurrently. It leaves spaces for future research on the net effect of exception disclosures with expanded samples. Finally, as 60% of respondents supported mandatory disclosure of trace amounts of unqualified ingredients in USDA Organic and NGPV products, future studies may take on the question of whether and how certifying entities and food manufacturers are obligated to eliminate labeling inefficiency.

APPENDIX

Appendix 1: Cornell IRB exemption letter

Cornell University
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Institutional Review Board for Human Participants

Notice of Exemption

To:	Geqing Zhou
From:	Andrew Willford, IRB Chairperson
Protocol ID#:	2113010810
Protocol Title:	Disclosure of Trace Ingredients in Certified Non#GMO and Organic Products and Impacts on Consumer Willingness to Pay
Approval Date:	January 10, 2022
Expiration Date:	None

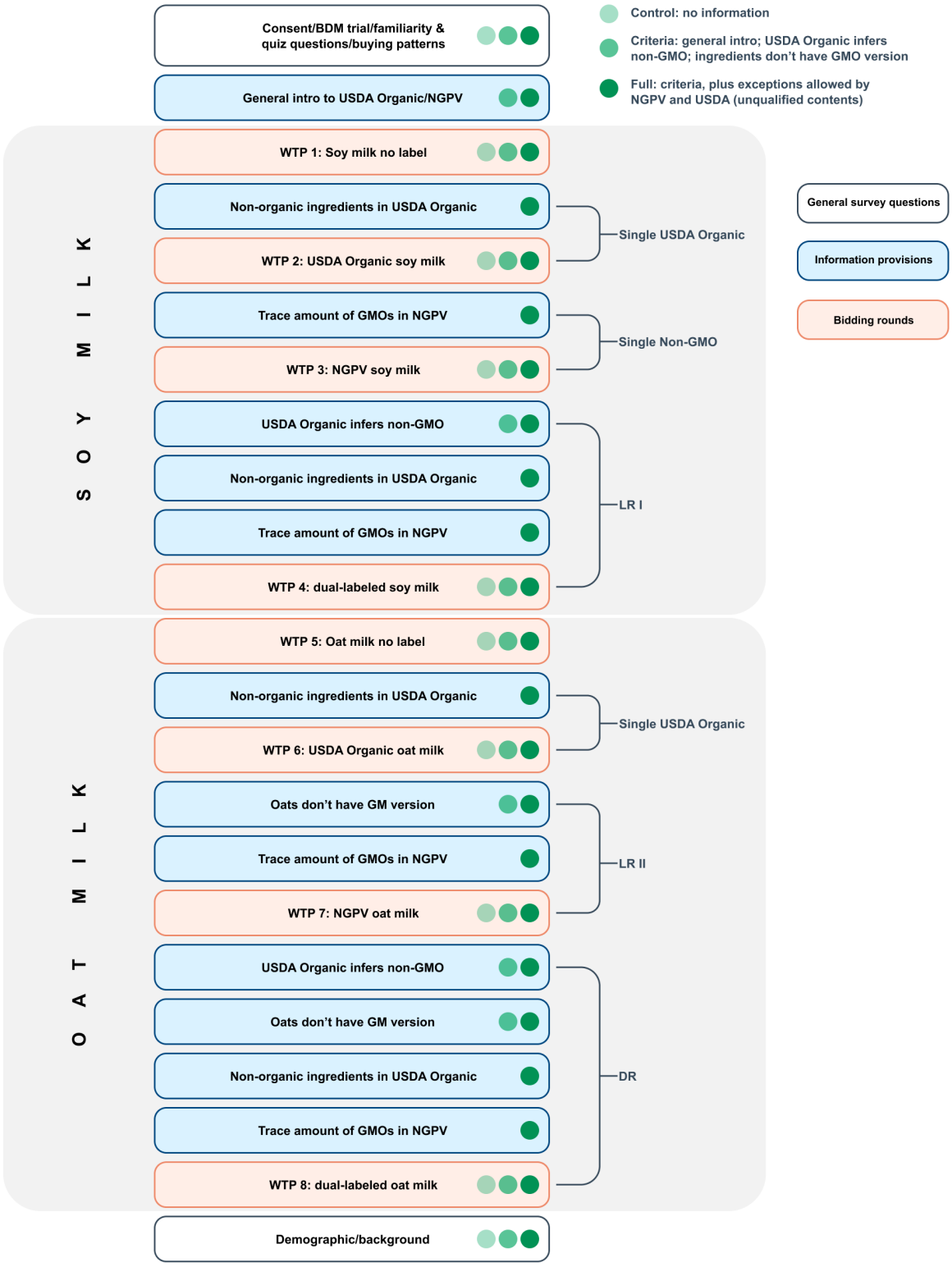
Your protocol has been granted exemption from IRB review according to Cornell IRB policy and under paragraph(s) 3 of the Department of Health and Human Services Code of Federal Regulations 45CFR 46.104(d).

• Paragraph 3 allows to be exempted from IRB review research activities in which the only involvement of human subjects will be in the following category: Benign Behavioral Interventions – Research involving benign behavioral interventions in conjunction with the collection of information from an adult subject through verbal or written responses (including data entry) or audiovisual recording if the subject prospectively agrees to the intervention and information collection, and if: i) the information obtained is recorded in such a manner that the human subjects cannot be identified, directly or through identifiers linked to the subjects; or ii) any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation..

Please note the following:

- Investigators are responsible for ensuring that the welfare of research subjects is protected and that methods used and information provided to gain participant consent are appropriate to the activity. Please familiarize yourself with and conduct the research in accordance with the ethical standards of the Belmont Report (https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/index.html).
- Investigators are responsible for notifying the IRB office of change or amendments to the protocol and acquiring approval or concurrence **BEFORE** their implementation.

Appendix 2: survey and treatment flow overview



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