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Valuing sustainability: Price premiums for dolphin-safe and MSC-certified canned tuna[☆]

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ABSTRACT

The evolution of ecolabels has led to many food products carrying multiple certifications for their environmental and ecological commitments. In the tuna market, the "dolphin-safe" label and the Marine Stewardship Council (MSC) certification are the most prominent. This paper uses a novel dataset that links Nielsen Retail Scanner data from 2017 to 2019 with ecolabel information to estimate the impact of different certifications on canned tuna prices. Applying a hedonic pricing model, we find significant price premiums for single labels, 25.4 % for dolphin-safe tuna, and 44.6 % for MSC-certified products. Our results also show that dual labeling yields a price premium of 81.3 %, substantially higher than the sum of the two individual effects. Moreover, the results underscore the potential of ecolabels to incentivize sustainable practices, with dual certification enhancing credibility and consumer trust amid increasingly complex certification systems.

1. Introduction

Ecolabels are certification marks used to signify that products or services meet specific environmental performance criteria, thus aiding consumers in making sustainable choices. These labels, governed by various national and international standards, evaluate factors such as resource efficiency, pollution reduction, and biodiversity conservation throughout a product's lifecycle (Gallastegui, 2002). Additionally, ecolabels drive market differentiation and competitive advantage, encouraging the adoption of greener practices industry-wide (Mason, 2006; Roe and Sheldon, 2007). The first seafood ecolabel "dolphin-safe" marks the beginning of the Sustainable Seafood Movement[1] and originates from concerns over declining populations of dolphins and other bycatch[2] seafood species in the Eastern Tropical Pacific (ETP) in the 1950s (Cezar, 2018; Potts and Haward, 2007). The birth of dolphin-safe label represents a market-force approach that encourages collective action among governments, industries, and consumers to ensure dolphin-friendly practices in tuna fishing and production (Kirby et al., 2014; Teisl et al., 2002; Ward, 2008) and has resulted in a significant reduction in dolphin bycatch in tuna fisheries operating in the Eastern Tropical Pacific (ETP).[3]

With such success, ecolabels serve as important tools to facilitate communication between consumers and producers, and the ecolabeling market has developed significantly (Roheim et al., 2018). Today, the

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[1] The Sustainable Seafood Movement, emerging from the broader Environmental Movement of the mid-to-late 1990s, aims to promote the consumption and trade of seafood sourced through environmentally responsible practices, responding to the alarming decline of global fish stocks and the inadequacy of government action (Gutiérrez and Morgan, 2015).

[2] Bycatch refers to an incident catch of some non-target species or discards of these species because of their low or zero economic values. The occurrence of bycatch is largely due to a lack of observation on the mortality of fishing vessels and gears (NOAA, 2019).

[3] It is important to note that the dolphin-safe label only guarantees that tunas are not harvested using purse seine with fish aggregating devices (FADs), but it does not ensure zero dolphin deaths (Ballance et al., 2021).

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Marine Stewardship Council (MSC) provides the most widely recognized ecolabel for wild-caught seafood. Founded in 1997, the MSC aims to combat overfishing and advocate for sustainable fisheries on a global scale. It establishes standards for sustainable stock management and mandates a chain of custody certification throughout the supply chain, ensuring that MSC-labeled products can be traced back to certified fisheries. According to the MSC, 550 fisheries were certified in 2022, and over 20,000 products with the MSC ecolabel available to consumers in 66 countries (MSC, 2024). While the MSC certification encompasses a broader range of sustainability criteria, including the overall health of fish stocks, ecosystem impacts, and responsible fisheries management practices (MSC, 2024), the dolphin-safe certification focuses specifically on reducing dolphin bycatch in tuna fisheries. These two ecolabels show differences but with common concerns in sustainability, and yet it remains unclear whether combining two certifications effectively signals stronger environmental responsibility to consumers.

In general, consumers have shown significant interest in ecolabeled seafood products (Johnston et al., 2000; Jaffry et al., 2004; Johnston et al., 2006; Brécard et al., 2009) and are willing to pay higher prices for them (Asche et al., 2015; Bronnmann and Asche, 2016, 2017; Zhang et al., 2020, Asche et al., 2021). Research indicates that attributes like country of origin, production methods, and sustainability preferences significantly influence consumer choices (Asche and Guillen, 2012; Claret et al., 2012; Zhang et al., 2020). Dolphin-safe labels have been shown to positively influence consumer demand (Teisl et al., 2002; Sun et al., 2017), and price premiums of on average 14 % are found for MSC-certified seafood (Asche and Bronnmann, 2017; Bronnmann and Hoffmann, 2018; Roheim and Zhang, 2018). However, results also indicate that the magnitude of the price premiums for ecolabeled seafood varies between markets and species (Sogn-Grundvåg et al., 2014; Bronnmann and Asche, 2017). We selected these two most representative ecolabels in the seafood market, dolphin-safe and MSC certification, to explore the impact of dual certifications on seafood pricing.

It remains controversial whether ecolabels can effectively drive production improvement[4] consistently as an increasing number of ecolabels emerge in the market, and the ecolabeling market has become a competition of what is the most sustainable production practice (Roheim et al., 2018). The increasing competition among ecolabels in the market has led to consumer confusion regarding their meanings (Winson et al., 2022; Bronnmann et al., 2021), raising concerns about the effectiveness of ecolabels. To understand the impact of different labels on enhancing production practices in seafood catch, this study is the first to investigate the effect of dolphin-safe labeling on tuna pricing in the U.S. market, as well as the combined impact of dolphin-safe and MSC certifications. Most tuna species consumed are not directly linked to dolphin bycatch, except for yellowfin tuna in the Eastern Tropical Pacific region (Zappes et al., 2016; MSC, 2023). Therefore, our study specifically focuses on chunk light tuna products in the U.S. market, which often use yellowfin tuna as the source closely related to dolphin bycatch (Hilger et al., 2019). By selecting these products, we aim to highlight the species most affected by dolphin bycatch, providing clear insights into the potential production implications of ecolabeling in this context.

Our study sources data on 276 canned tuna products from 13,750 stores, including matched ecolabel certification information. This innovative dataset, which links Nielsen Retail Scanner data with certifications of dolphin-safe and MSC labels, enables us to investigate the revealed price premiums for these labels. Following previous studies on hedonic pricing regressions (Asche and Bronnmann, 2017; Pettersen and Asche, 2020; Ray et al., 2022; Roheim et al., 2007; Roheim et al., 2011; Sogn-Grundvåg et al., 2013, Bronnmann et al., 2023), we apply the hedonic pricing model to examine the pricing dynamics of canned tuna products in the U.S. market. Our findings reveal that both the dolphin-safe and MSC ecolabels individually command a favorable price premium, with 25.4 % for dolphin-safe tuna and 44.6 % for MSC-certified products. Products carrying both labels show a premium of 81.3 %, indicating that combining ecolabels can generate higher price premiums and provide more substantial incentives for producers compared to a single label.

The paper is structured as follows: in the next section, we introduce the background of tuna protection in the sustainable seafood movement and review the literature on seafood ecolabels. Next, data used for analysis in this study is described and the U.S. tuna market is introduced. Then the method to evaluate the value of different characteristics of tuna products is given. Empirical results of hedonic pricing regression are given before the final concluding remarks are offered.

2. Background

Concerns about dolphin bycatch[5] led to practices prioritizing dolphin conservation during tuna harvests starting from the 1970s and 1980s (Hall, 1998; Ballance et al., 2021). The rising awareness of bycatch mortality rates from the U.S. public and the need for conservation efforts resulted in the implementation of the Marine Mammal Protection Act (MMPA) in 1972. This legislation presented a significant challenge for the tuna industry, urging improvements in tuna catch methods by eliminating the use of gillnets and longlines that were particularly harmful to dolphins (Potts and Haward, 2007; Hampton, 1998; Brown, 2005).

To comply with domestic regulations and the MMPA, U.S. companies began exploring alternative international sources for tuna. In the late 1980s, several U.S. companies formed partnerships with Asian firms not subject to U.S. dolphin bycatch restrictions. This strategy enabled them to maintain tuna supplies despite domestic constraints, though it did not fully resolve dolphin conservation concerns (Constance et al., 1995). As dolphin kills continued, international organizations increasingly recognized the need for coordinated efforts, given the migratory nature of tuna (FAO, 2010). Non-government organizations such as the Inter-American Tropical Tuna Commission (IATTC) intervened, but their impact was limited due to the prevalence of illegal, unreported, and unregulated (IUU) tuna fishing practices, including reflagging issues[6] to avoid regulations (Gomez et al., 2020; Polacheck, 2012).

In the 1990s, consumer boycotts[7] in the U.S. led to the establishment of the dolphin-safe ecolabel, the first seafood ecolabel initiated by the Earth Island Institute and its cooperating tuna companies (NOAA, 2019). These boycotts and the introduction of the "dolphin-safe" label became effective market tools for promoting environmentally responsible production practices and informing consumers about sustainability (Gudmundsson and Wessells, 2000; Wessells et al., 1999). As a result, significant measures were adopted, including the implementation of the Dolphin Protection Consumer Information Act of 1990 and trade embargoes imposed by the U.S. on Mexico and other tuna-exporting countries (Constance et al., 1999). These policies drove a substantial spatial shift in tuna processing, with canning operations ceasing in

[4] Production improvement refers to enhancements in efficiency, sustainability, and overall product quality driven by the adoption of ecolabels.

[5] Dolphin bycatch refers to the accidental capture and subsequent death of dolphins during tuna harvesting. For example, skipjack tuna is frequently caught using purse seine fishing methods, which can inadvertently entangle dolphins, particularly when tuna schools are located near groups of dolphins (Davies et al., 2014).

[6] Reflagging refers to the practice of ships changing their country of registration (or "flag") to one with more lenient regulations or lower operational costs, often to avoid stricter environmental or labor laws. This practice can have significant implications for fishing operations and sustainability efforts (Miller and Sumaila, 2014).

[7] In the 1990s, Samuel LaBudde's video exposing dolphin deaths during tuna catch sparked public outrage, leading to public campaigns for dolphin protection and pressuring tuna companies to prioritize their safety (IMMP, 2023).

mainland United Statesd (Hicks and Schnier, 2006; FAO, 2010). Despite these advances, dolphin bycatch remains a persistent concern today, as many companies have continued to shift production to jurisdictions with weaker enforcement rather than adopting more sustainable practices (Ward, 2008). This ongoing challenge has contributed to continued debate about the long-term effectiveness of seafood ecolabels in reducing bycatch and improving marine conservation outcomes.

Previous studies have shown a strong market demand for sustainable seafood, supported by both hypothetical survey-based findings and actual market premiums. Extensive research on seafood consumers has found positive premiums and WTP for certain ecolabeled seafood species (Asche et al., 2015; Bronnmann and Asche, 2016; Asche and Bronnmann, 2017; Bronnmann and Hoffmann, 2018; Roheim et al., 2011; Nguyen et al., 2015; Sogn-Grundvag and Young, 2013; Sun et al., 2017, Bronnmann et al., 2021; Bronnmann et al., 2023). These studies focus on the preferences and willingness to pay for a single ecolabel, but as multilabel certification becomes more popular in the market, some studies have compared the effects of different ecolabels. Sigurdsson et al. (2022) found that ecological labels, such as Aquaculture Stewardship Council (ASC), are not as effective as sustainability tags with more apparent descriptions for production in informing consumers. Hilger et al. (2019) also found that certain sustainability labels might negatively impact consumers' willingness to pay (WTP). While such WTP investigations show an important marketing signal, in some cases, the stated preferences could be hugely different from actual purchasing behavior (Hensher and Bradley, 1993). Therefore, investigations on pricing mechanisms have been widely applied to reveal more market information (Asche and Bronnmann, 2017; Pettersen and Asche, 2020; Ray et al., 2022).

Research shows that variations in premiums can be attributed to different product attributes, including ecolabels, with price premiums for ecolabeled seafood indicating potential improvements during production practices (Bronnmann et al., 2023; Leadbitter and Benguerel, 2014). It has been shown that the MSC label commands positive price premiums, with price variations in seafood products influenced by factors such as selective fishing methods, consumer demand for sustainability, market dynamics, and the specific brands or suppliers involved (Lee, 2014; Asche et al., 2015; Asche et al., 2021; Hilger et al., 2019; Zhang et al., 2018). Additionally, food safety concerns and environmental impacts affect premiums, considering species, product characteristics, distribution channels, and fishing methods (Asche and Bronnmann, 2017; Carroll et al., 2001; Pettersen and Asche, 2020; Ray et al., 2022; Roheim et al., 2007; Roheim et al., 2011; Sogn-Grundvåg et al., 2013; Sogn-Grundvåg et al., 2021; Wolff and Asche, 2022; Lim et al., 2018).

The segmentation of the seafood market reveals significant variations in premiums by species. However, there is a lack of research investigating the combined price premiums for multiple ecolabels. There is a growing trend that consumers are attracted to additional information, such as fishing methods and other sustainability tags (Sogn-Grundvåg et al., 2013). As the diversity of the seafood ecolabeling market increases, it becomes important to investigate the pricing dynamics and determine whether sustainable labels can effectively incentivize production practices, given that consumers now have a broader range of options for eco-friendly and sustainable choices. If price fails to reflect these improvements, producers may lose motivation for further progress in ecolabel certifications due to lack of incentives (Asche et al., 2015). Hence, price signals are important for producers if they are adopting sustainable practices.

3. Data and U.S. tuna market

Tuna products often come with a wealth of detailed information, due to the various species, fishing methods, and sustainability concerns. Different tuna species and products require specific fishing methods (Brown, 2005). Skipjack tuna, the most caught species globally,[8] is commonly used for canned tuna and caught using purse seine nets (FAO, 2023). However, purse seine nets with fish aggregating devices (FADs) have raised concerns about bycatch, including dolphins, whales, turtles, sharks, and other non-commercial species (FAO, 2010). To address these concerns, retailers are offering information about tuna harvest using free-school techniques.[9] Yellowfin and albacore are also used in some canned tuna products (FAO, 2023). Other tuna species, such as bluefin and bigeye tuna, are primarily caught for sashimi consumption (MSC, 2023).

Knowledge about tuna species can help reveal production methods and whether they are associated with dolphin bycatch (Hall et al., 2017). Canned tuna products offer a variety of flavors and types. In the U.S. market, chunk light, solid white, and chunk white are the popular forms representing different species, flavors, and textures. "White" tuna refers to albacore, while light tuna is typically yellowfin and skipjack, with colors ranging from tan to pink. The terms chunk, solid, and fillet indicate the size of tuna pieces in the can. Chunk is the smallest, solid has larger, firmer pieces with fewer flakes, and fillet features the largest intact fillets. This information helps verify the tuna species and relates to their production method. Therefore, in our final data selection, we focus exclusively on chunk light tuna, which is most closely associated with dolphin bycatch.

The data of canned tuna products used in this study were obtained from Nielsen Retail Scanner database, which provides store-level price, sales and product attributes of canned tuna product data from 2017 to 2019.[10] The price is proxied using the unit value,[11] which is calculated as the total monthly revenue (measured in U.S. dollars) divided by the total monthly volume (measured in ounces). To address outliers, we trimmed the price-per-ounce distribution at the 1st percentile (unit prices below $0.14/oz) and removed a single outlier priced at $86/oz. This procedure excluded 1 % of observations from the tail and eliminated extreme values likely attributable to reporting errors or sale activities, such as prices below $0.05/oz. We focus on stores from the grocery store channel where most canned tuna is sold. This represents more than 50 % of the total sales volume across the U.S. nationwide. In our sample, we only selected stores that sell chunk light canned tuna, and each canned tuna product is identified by a unique UPC code.[12] To capture the sales pattern, we aggregated the data at the monthly level. In our sample, the data includes 207 canned tuna UPCs across 13,750 stores and 204 designated market areas (DMAs) over a span of 36 months, totaling 9363,652 observations.

For ecolabeling information, NOAA Fisheries carries out regular checks on canned tuna products in U.S. retail stores to verify label authenticity and update dolphin-safe labeled tuna brand names accordingly (NOAA, 2023). To identify dolphin-safe labeled tuna products, we merge the canned tuna sales data from Nielsen with dolphin-safe labeling data from NOAA using brand names as the key. In

[8] Skipjack tuna catch represents over 60 % of the total catch (FAO, 2023).

[9] The free-school technique is a fishing method where fishers use sound and sight to locate tuna in open water, away from dolphins or other structures, and encircle them with nets, offering a more sustainable alternative to purse seining near dolphins by reducing the risk of dolphin bycatch (Guillotreau et al., 2011).

[10] Nielsen data contains weekly pricing, volume, and attributes of UPC-level products, as well as store demographics such as store channel type, geographic location (state and county), and designated market area (DMA). The US is divided into 210 DMAs. We investigate the period before the pandemic to mitigate the influence of external factors on tuna consumption. Also, due to the availability of MSC data, we select the period from 2017 to 2019.

[11] The price is adjusted using the Consumer Price Index (CPI) with 2017 January as the base one.

[12] A summary of the tuna products in the U.S. market by category is given in Table A1 in appendix.

our sample data, 96.9 % of sold tuna have dolphin-safe labels.

To identify tuna products carrying the MSC label, we used the UPC code and brand names and match these to a list of MSC certified products, which we got from the MSC logo license management. Despite being the leader in global wild-capture fisheries certification, the market share of MSC certified seafood remains relatively low, accounting for approximately 19 % of the international market (Miret-Pastor et al., 2014; MSC, 2023). In our dataset, 2.17 % are MSC certified products, 0.86 % carry both the dolphin-safe and MSC label. Table 1 provides the descriptive statistics of the prices of the relevant product attributes in $ per oz.

Measured at the product level, Table 2 provides proportions of different labeling strategies for 85 brands in our sample in the U.S. canned tuna market over a three-year period from 2017 to 2019. Although the percentage of tuna labeled as dolphin-safe has remained steady, there has been a decline in the certification of chunk light canned tuna during 2017–2019. On the contrary, there has been a growing adoption of the MSC label among brands over this period. Brands with dual labels (both dolphin-safe and MSC) started from a very low proportion in 2017 (2.0 %) and increased to 6.8 % in 2019. This hike indicates a strong trend toward brands adopting both labels together in their labeling strategy. Moreover, an increasing number of brands are opting to certify with ecolabels, with the proportion of brands not certifying with either of the two labels declining from 13.4 % in 2017–6.2 % in 2019.

Table 3 presents the price developments for products under each labeling strategy over the period under study. The overall average price of canned tuna has risen over the three-year period. Specifically, products labeled as dolphin-safe only have the lowest average price among the four labeling categories. However, their price remains relatively stable, increasing slightly from $0.398/oz in 2017 to $0.418/oz in 2019. In contrast, the MSC-only category exhibits significantly higher prices compared to other categories, and these prices increase over the years ranging from $1.420/oz to $1.559/oz. For tuna with both dolphin-safe and MSC certifications (named as Dual-labels in Table 2), the price drops from $0.613/oz in 2017 to $0.449/oz in 2019. The declining price of dual-labeled products is likely driven by the increased market presence and competition and the entry of lower-priced brands that adopted dual labeling over time.[13] It is also noted that products with neither label are slightly above average price and become more expensive over time. This could be attributed to smaller or niche brands, which may focus on premium positioning, and therefore price their products higher (Jarvis and Goodman, 2005).

Table 1
Descriptive Statistics of the relevant product attributes.

Product Attribute	**Purchase frequency in %**	price of the product attribute in $ per oz			
		Mean	**Min**	**Max**	**Std. Dev.**
Labels and Brand					
DFSF	96.93	0.41	0.13	5.06	0.18
MSC	2.17	0.52	0.13	1.97	0.23
Dual	0.86	0.48	0.13	4.86	0.36
No Label	0.04	1.54	0.23	2.01	0.26
T5 Brand	97.29	0.41	0.13	5.06	0.18
Package Size					
Small	54.70	0.53	0.13	4.86	0.14
Medium	32.95	0.27	0.13	5.06	0.13
Large	12.34	0.26	0.13	0.74	0.07
Saltiness					
Regular Salt	94.06	0.41	0.13	5.06	0.19
Low salt	5.85	0.42	0.13	3.82	0.15
No salt	0.09	0.54	0.17	0.80	0.07
Flavour					
Regular flavour	62.50	0.33	0.13	5.06	0.17
Other Flavour	23.30	0.55	0.13	3.83	0.14
Lemon pepper	5.16	0.53	0.14	3.83	0.12
Ranch	3.31	0.53	0.14	3.82	0.12
Sweet Spicy	3.25	0.52	0.13	3.82	0.12
Smoked	2.48	0.51	0.14	3.82	0.12
Year					
2017	25.73	0.40	0.14	3.97	0.19
2018	35.25	0.41	0.14	5.06	0.18
2019	39.02	0.42	0.13	5.02	0.19
Overall average		0.41	0.13	5.06	0.19

Table 2
Label proportion in the chunk light canned tuna market in the U.S.

Year	Dolphin-safe Only	MSC Only	Dual-labels	Neither
2017	83.9 %	0.7 %	2.0 %	13.4 %
2018	83.5 %	0.6 %	4.0 %	11.9 %
2019	85.9 %	1.1 %	6.8 %	6.2 %

Table 3
Average price development of canned tuna (chunk light) with different ecolabels.

Year	Dolphin-safe Only ($/oz)	MSC Only ($/oz)	Dual-labels ($/oz)	Neither ($/oz)	Full Sample ($/oz)
2017	0.40	1.44	0.62	0.38	0.40
2018	0.42	1.54	0.60	0.49	0.42
2019	0.44	1.64	0.47	0.54	0.44

4. Method

A hedonic model estimates the marginal value or price of a product or service by analyzing its attributes. It assumes that a product's price is influenced by its specific attributes and how consumers value them, with the marginal price of an attribute reflecting consumers' willingness to pay for it (Rosen, 1974). This approach quantifies the impact of each attribute on the overall price, offering insights into consumer preferences and market dynamics. The hedonic model has been widely applied in seafood pricing to examine the value of various characteristics (Asche et al., 2015; Asche and Bronnmann, 2017; Botta et al., 2023; McConnell and Strand, 2000; Ray et al., 2022; Wolff and Asche, 2022).

Lancaster's (1966) theory, which underpins the hedonic model, suggests that consumers derive utility from a product's attributes rather than the product itself. The price of goods is determined by the number of these attributes, with each characteristic having a unique implicit price (Costanigro et al., 2007; Saló et al., 2014). In seafood pricing, models often include attributes like brands, package size, product forms, and species (Roheim et al., 2007; Roheim et al., 2011; Sogn-Grundvåg et al., 2014; Bronnmann and Asche, 2016; Asche and Bronnmann, 2017; Asche et al., 2021). Sensory attributes such as smell, color, saltiness, and flavor also significantly influence consumer choices and prices (Zhang et al., 2020).

We conducted a Box-Cox test to decide between log-linear and linear models for our analysis. The test results showed that the log-linear model had the lowest chi-square value, making it our preferred model (Malpezzi, 2002; Taylor, 2003). We follow Asche and Bronnmann (2017) and specify the following log-linear hedonic price function:

$$\ln(P_{ist}) = \beta_0 + \beta_1 DFSF_i + \beta_2 MSC_{it} + \beta_3 DFSF_i * MSC_{it} + \beta_4 T5brands_i + \beta_5 Packsize_i + \beta_6 Salt_i + + \beta_7 Flavor_i + \gamma_t + \gamma_s + \quad e_{ist}, \tag{1}$$

[13] Our analysis comparing switchers (brands that adopted dual labeling after previously being non–dual-labeled) and non-switchers (brands dual-labeled for one or two years) shows that non-switchers consistently command higher prices ($0.578/oz) than switchers ($0.293/oz).

where $\ln(P_{ist})$ is the logarithm of the price of product i in store s at month t. A summary statistic of variables used in this study is given in Table 1. The fixed-effect include month-by-year fixed effect (γ_t), and store fixed effect (γ_s). e_{it} is the random error term. We incorporate the time shock by controlling for the month by the year fixed effect. Additionally, we account for spatial impacts on consumers' decisions through store effects. Such time-variant unobservable factors will be controlled to understand pricing dynamics. An overall variance inflation factor (VIF) of 1.60 indicates that multicollinearity is not an issue. Because prices of similar tuna products are likely correlated both within markets and across time, we adopt two-way clustered standard errors for all main inferences, clustering (i) by DMA and (ii) by product-time (year × month × size × saltiness × flavor). This accounts for spatial and temporal dependence in unobserved shocks and ensures conservative inference (Cameron and Miller, 2015).

The coefficients $\beta_1, \beta_2, \quad \beta_3$ are key estimates that reflect the impact of different labels on price. To calculate the price premiums, we use the approach of Halvorsen and Palmquist (1980) as follows:

$$Percentage\ Effect = (e^{Coefficient} - 1) * 100$$

Specifically, we can compare the price premiums for the "DFSF only", "MSC only" and "dual labels" products with "non-labeled" products. For the "DFSF only" products, the following conditions hold: $DFSF_i = 1, MSC_{it} = 0$, and $DFSF_i * MSC_{it} = 0$. The average price premium for the "DFSF only" product relative to non-labeled products is given by:

$$(e^{\beta_1} - 1) * 100$$

For the "MSC only" products, the conditions are $DFSF_i = 0$, $MSC_{it} = 1$, and $DFSF_i * MSC_{it} = 0$. The average price premium for the "MSC only" product, relative to non-labeled products, is:

$$(e^{\beta_2} - 1) * 100$$

Finally, for the dual-labeled products, where both labels are present, $DFSF_i = 1, MSC_{it} = 1$, and $DFSF_i * MSC_{it} = 1$, the average price premium for the dual-labeled products is calculated as:

$$(e^{\beta_1 + \beta_2 + \beta_3} - 1) * 100$$

5. Results and discussions

Table 4 reports the log-linear hedonic pricing model, taking the logarithm of the unit value in the estimate equation. Model 1 and Model 2 consider a single label of dolphin-safe or MSC, while Model 3 corresponding to Eq. (1) is the preferred model that incorporates the combined effects of the dual labels. [14]

As shown in Table 4, Model 1 assesses the impact of the dolphin-safe label alone, revealing that products labeled as dolphin-safe are priced approximately 34.0 % higher than their non-labeled counterparts, holding other factors constant. Model 2 examines the price effect of the MSC label, showing a significant price increase of 49.1 % for MSC-certified products compared to non-certified ones. This substantial price premium underscores the strong influence of the MSC label on consumer purchasing behavior.

Model 3 illustrates how price premiums vary in response to the two ecolabels. When including the interaction effect, results show that canned tuna products with only the dolphin-safe label are, on average, 25.4 % more expensive than those without either label, while products with only the MSC label are 44.6 % more expensive on average than those without any labels. Products with both labels command a statistically significant 81.3 % higher unit value compared to those without either label. Overall, the results emphasize the importance of certification labels in the marketplace, with dual-labeled products commanding the highest price premiums.

The model also explores the impact of brand status, represented by T5brands, which refers to the top five brands in the market. As is shown in Table 4, the negative and significant coefficients for T5brands across all models suggest that these top brands tend to offer lower prices compared to others. This may be because the top five companies in our dataset hold significant market shares, allowing them to sell tuna at lower prices due to economies of scale and reduced costs.

The model highlights several additional factors with significant price effects. For example, package size plays a crucial role: on average, smaller packages, compared to medium-sized ones, command a substantial price premium of approximately 120 %, while larger packages are priced only slightly higher, with increases ranging from 9.3 % to 9.4 %. Variations in salt content and flavor also significantly impact pricing. Options such as no salt and low salt, as well as flavors like lemon pepper and ranch, contribute to positive price premiums relative to their respective base categories.

Moreover, the models incorporate month-by-year fixed effects (FE) and store fixed effects, ensuring that the estimated price effects account for temporal and location-specific variations. The consistently high R-squared values across the models (ranging from 0.727 to 0.730) indicate that the log-linear model effectively captures a substantial proportion of the variation in product prices. To ensure the validity and reliability of our findings, we conduct robustness checks. The robustness checks, summarized in Appendix Table A3, demonstrate that our results are stable across a range of alternative specifications, including models using quarterly data (column 1), restricting the sample to the top four brands (column 2), adding DMA fixed effects (column 3), excluding covariates (column 4), and employing Poisson regression (column 5). Across all cases, dolphin-safe products command premiums between 17.4 % and 37.4 %, while MSC-certified products yield substantially higher premiums ranging from 33.8 % to 246.3 %. Importantly, dual-labeled products also exhibit consistently large and statistically significant premiums, ranging from 77.3 % to 107.1 %, further underscoring the robustness of the results.

We also run an additional variation of Model 3 that includes label-year interactions (rather than a single indicator for each label) for each year from 2017 to 2019 to assess the stability of the label effect over time. Fig. 1 shows the price premiums for the labels over time and the respective 95 % Confidence Intervals (CI). It can be seen that MSC declines from 139.5 % (2017) to 69.6 % (2018) and 40.3 % (2019); DFSF is relatively stable (27.6 %, 26.5 %, 21.3 %), and Dual falls from 127.3 % to 104.1–53.0 %.

Additionally, we conducted robustness checks on clusters by different methods, such as by time and regions, as shown in Appendix Table A4, all of which yielded consistent results.[15] As expected, the standard errors increase when moving from robust to clustered specifications, reflecting the presence of within-cluster correlations. Despite these increases, the estimated coefficient remains statistically significant under all specifications, confirming the robustness of our main results. Based on this comparison, we adopt the most conservative and appropriate specification, employing two-way cluster-robust standard errors clustered by Designated Market Area (DMA) and by product-time characteristics, defined as the interaction of year, month, size, saltiness, and flavor, for all main inferences. This approach effectively accounts for spatial and temporal correlations in shocks that affect similar products within the same regional markets.

[14] The estimates also echo these in the linear model (Table A2).

[15] Robust standard errors are reported in column (1). Columns (2)–(7) present standard errors clustered at different levels: by store (11,761 clusters), by product–time (471 clusters), by both store and product–time (11,761 store clusters and 471 product–time clusters), by DMA (201 clusters), by both DMA and time (201 DMA clusters and 36 time clusters), and by both DMA and product–time (201 DMA clusters and 471 product–time clusters).

Table 4
Coefficients and price effects log-linear model.

Variables	Model 1 Coefficients	Price Effect (in %)[a]	Model 2 Coefficients	Price Effect (in %)[a]	Model 3 Coefficients	Price Effect (in %)[a]
DFSF	0.293***	**34.0**			0.226***	**25.4**
	(0.076)				(0.069)	
MSC			0.399***	**49.1**	0.369***	**44.6**
			(0.053)		(0.078)	
DFSF*MSC					−0.012	**81.3**
					(0.014)	
T5brands	−0.376***	**−31.3**	−0.185**	**−16.9**	−0.303***	**-26.2**
	(0.090)		(0.066)		(0.082)	
Package size (base: medium)						
Small	0.792***	**120.7**	0.787***	**119.7**	0.789***	**120.0**
	(0.010)		(0.010)		(0.010)	
Large	0.090***	**9.39**	0.089***	**9.3**	0.091***	**9.4**
	(0.012)		(0.013)		(0.012)	
Saltiness (Base: Regular salt)						
No salt	0.669***	**95.3**	0.646***	**90.8**	0.698***	**101.0**
	(0.066)		(0.057)		(0.058)	
Low salt	0.086***	**9.0**	0.090***	**9.4**	0.047***	**9.4**
	(0.020)		(0.020)		(0.015)	
Flavor (Base: Regular flavor)						
Lemon pepper	0.043**	**4.38**	0.048***	**4.9**	0.048***	**4.8**
	(0.015)		(0.015)		(0.015)	
Sweet spicy	0.043*	**4.10**	0.049**	**4.6**	0.045***	**4.6**
	(0.015)		(0.015)		(0.015)	
Ranch	0.040*	**3.93**	0.043**	**4.4**	0.043***	**4.4**
	(0.015)		(0.015)		(0.001)	
Smoked	0.031*	**3.14**	0.035*	**3.6**	0.040***	**3.6**
	(0.017)		(0.017)		(0.015)	
Other flavor	0.045***	**4.62**	0.050***	**5.1**	0.050***	**5.1**
	(0.013)		(0.013)		(0.013)	
Constant	−1.515***		−1.414***		−1.522***	
	(0.041)		(0.064)		(0.041)	
Month-by-year FE	Y		Y		Y	
Store FE	Y		Y		Y	
Observations	9363,652		9363,652		9363,652	
Within R-squared	0.692		0.694		0.696	
Overall R-squared	0.727		0.729		0.730	

Notes: Two-way cluster standard errors (clustered by Designated Market Area (DMA) and by product-time, defined as year × month × size × saltiness × flavor) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Relative to base category, adjustments made according to Halvorsen and Palmquist (1980). Significant price premiums are in bold.

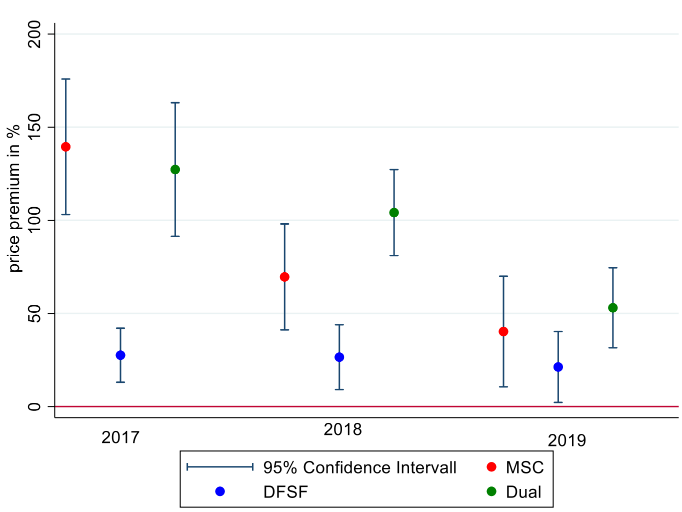

Fig. 1. 95 % Confidence Interval (CI) and price premiums in a specific year.

6. Conclusions and discussions

This study investigates the impact of dolphin-safe and MSC labels on the price of canned tuna in the U.S. market, comparing products with multiple labels to those without any ecolabels. Our results show that chunk light tuna, primarily containing yellowfin tuna that are most closely associated with the dolphin protection and ecological concerns, commands price premiums from both the dolphin-safe label and MSC certification. Notably, the price premium for dolphin-safe products is significant, with a 25.4 % increase compared to non-certified alternatives. MSC-certified products exhibit even stronger premiums, offering a competitive edge with a 44.6 % premium over non-certified products. Dual-labeled products achieve the highest premium, commanding an 81.3 % increase in price.

The rise of ecolabels in the sustainable seafood movement has empowered consumers to make informed choices and drive positive changes in production practices (Roheim et al., 2018). Ecolabels initially encourage sustainable practices, but as their market share grows, the introduction of varied label descriptions offers consumers a broader range of eco-friendly and sustainable choices. Consumers face overloaded information and sometimes are confused about the ecolabeling programs (Horne, 2009). Some consumers are found to be attracted to additional information rather than ecolabels such as fishing methods and other sustainability tags (Sogn-Grundvåg et al., 2013). This raises concerns about the ongoing effectiveness of ecolabels, particularly as the market expands with different information on sustainability and types of certified products (Roheim et al., 2018; Smith et al., 2010).

Our research is the first in seafood literature to compare the value of the dolphin-safe label and MSC certification in tuna products. This study also highlights the potential effectiveness of dual labeling in enhancing product value. Moreover, the implications of this study extend beyond the seafood industry. The development of multi-labeling systems, which are increasingly common across various food categories, offers important insights for other sectors as well.

While this research provides insights into the price mechanism in the tuna market, it has certain limitations. One key limitation pertains to the role of periodic sales prices and promotional pricing on observed price dynamics. Our main specification estimates average price premiums over the full sample period (2017–2019), which may mask short-term variation. To account for this, we estimated year-specific premiums by interacting labels with year. As shown in Fig. 1, these interactions reveal meaningful changes over time, particularly a decline in the MSC and dual-label premiums, while the dolphin-safe premium remains relatively stable. These findings underscore the importance of accounting for temporal dynamics when interpreting average effects. Promotional discounts and temporary price reductions are common in the retail sector and can lead to short-term price fluctuations that are not fully captured by our hedonic model. Such variation may influence consumer purchasing behavior in ways that attenuate or amplify the observed premiums, highlighting the need for caution when generalizing from average effects across multiple years. While our model controls for store and time fixed effects, which help mitigate some of these concerns, future research could benefit from more granular transaction-level data that explicitly accounts for price promotions and discounting strategies to further refine the estimation of ecolabel effects.

Our findings highlight the importance of dual labeling in the tuna market. However, implementing dual-labeling systems could lead to unnecessary cost increases, raising important concerns about the tension between the lack of standardized certification systems and the growing demand for sustainable seafood. To prevent consumers from paying extra without added value, it is important to establish widely recognized ecolabeling standards and minimize unnecessary competition in advertising. It also remains unclear how consumer confusion over multiple ecolabels influences market outcomes, such as whether it leads to decreased trust or a lower perceived value of certified products. Additionally, uncertainty remains regarding the factors contributing to price premiums, as explored by Bronnmann et al. (2021), who suggest that these premiums are primarily driven by demand for sustainability. However, as discussed by Sun et al. (2017), there is a lack of evidence showing transfer of these premiums from the demand side to primary producers. If premiums do not reach the primary producers, this could distort the incentive structure of ecolabels and undermine their effectiveness in promoting sustainable practices.

Consumer misperception of competing eco-labels can undermine the incentives for sustainable suppliers (Brécard, 2017), while price disparities between differently labeled products may arise due to factors such as varying consumer perceptions, brand reputation, certification costs, and the degree of market penetration for each label (Nakaishi and Chapman, 2024). Future research could examine how consumer awareness and perceptions of multiple ecolabels evolve over time, especially as the number of certifications continues to expand. In addition, examining the long-term effects of dual labeling and redundant labeling on both consumer behavior and market dynamics would provide critical insights for the sustainable seafood industry. We also recognize that smaller or niche brands, which may focus on premium positioning, could have a different pricing dynamic. These brands often rely on differentiating factors, such as quality, sustainability, or exclusivity, which can justify higher prices despite their smaller market presence (Jung and Jin, 2014; Olson, 2013). This could offer valuable insights into how different market segments respond to labeling and certification in different ways. These areas of inquiry could help refine ecolabeling strategies to balance sustainability goals with market efficiency and consumer trust.

CRediT authorship contribution statement

Julia Bronnmann: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Methodology, Investigation, Conceptualization, Supervision. **Lingxiao Wang:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yingkai Fang:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix 1

Table A1 presents detailed unit values and rates of dolphin-safe labeling for six major product forms in the tuna industry. These forms include chunk light, chunk white, solid light, solid white, fillet light, and fillet white. Chunk light is the most popular choice (50.5 %), followed by solid white (20.3 %), chunk white (13.5 %), fillet white (8.3 %), solid light (3.2 %), and fillet light (0.9 %). The remaining product forms are grouped as “other form”, comprising 3.3 % of unit sales. Among them, chunk light is the least expensive, while fillet white is the priciest. Chunk light canned tuna has the highest proportion of dolphin-safe labeling (98.9 %), while solid light canned tuna has the lowest (79.3 %).

Table A1
Unit Values and Dolphin-safe Labeling across Six Major Product Forms

Product form	Unit value	Unit value (Dolphin-safe)	Unit value (Non-Dolphin-safe)	Dolphin-safe proportion
Chunklight	0.427	0.426	0.462	98.9 %
Chunkwhite	0.574	0.562	1.133	97.8 %
Solidlight	0.506	0.470	0.642	79.3 %
Solidwhite	0.427	0.418	0.831	97.7 %
Filletlight	0.708	0.612	1.108	80.6 %
Filletwhite	0.638	0.625	1.688	98.8 %

Appendix 2

Table A2
Estimates of hedonic price function in linear model

	(1)	(2)	(3)
VARIABLES	Price	Price	Price
DFSF	0.125***		0.103***
	(−0.027)		(−0.025)
MSC		0.146***	0.522***
		(−0.018)	(−0.081)
DFSF*MSC			−0.397
			(−0.830)
T5brand	−0.159***	−0.080***	−0.134***
	(−0.031)	(−0.024)	(−0.027)
Small	0.259***	0.257***	0.258***
	(−0.005)	(−0.005)	(−0.005)
Large	0.020***	0.019***	0.020***
	(−0.003)	(−0.004)	(−0.003)
Nosalt	0.201***	0.188***	0.217***
	(−0.029)	(−0.020)	(−0.025)
Lowsalt	0.019***	0.020***	0.020***
	(−0.006)	(−0.006)	(−0.006)
Lemonpepper	0.014**	0.016**	0.016**
	(−0.006)	(−0.006)	(−0.006)
Sweetspicy	0.011	0.013*	0.013*
	(−0.007)	(−0.007)	(−0.007)
Ranch	0.011	0.012*	0.012*
	(−0.007)	(−0.007)	(−0.007)
Smoked	0.005	0.007	0.007
	(−0.008)	(−0.008)	(−0.008)
Otherflavor	0.015***	0.017***	0.017***
	(−0.005)	(−0.005)	(−0.005)
Constant	0.242***	0.287***	0.238***
	(−0.015)	(−0.024)	(−0.015)
Store FE	Y	Y	Y
Month by Year FE	Y	Y	Y
Observations	9363,652	9363,652	9363,652
R-squared	0.613	0.618	0.619

Note: Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Appendix 3

Table A3
Robustness checks

	(1) Quarter Data	Price Premium (%)	(2) Top4 Brand	Price Premium (%)	(3) DMA FE	Price Premium (%)	(4) No Flavor Covariates	Price Premium (%)	(5) Possion	Price Premium (%)
dfsf	0.216***	**24.1**	0.160**	**17.4**	0.316***	**37.1**	0.227***	**25.5**	0.318***	**37.4**
	(0.080)		(0.074)		(0.044)		(0.069)		(0.071)	
msc	0.360***	**43.3**	0.291***	**33.8**	1.242***	**246.3**	0.345***	**41.2**	0.313***	**36.8**
	(0.084)		(0.068)		(0.026)		(0.075)		(0.102)	
dfsf_msc	−0.003	**77.3**	0.174***	**86.6**	−0.829***	**107.1**	0.005	**78.1**	−0.000	**88.0**
	(0.099)		(0.143)		(0.059)		(0.139)		(0.106)	
Top4brand			−0.230***	**−20.6**						
			(0.087)							
small	0.797***	**121.8**	0.788***	**119.8**	0.798***	**122.1**	0.818***	**126.7**	0.794***	**121.1**
	(0.015)		(0.010)		(0.009)		(0.007)		(0.010)	
large	0.085***	**8.9**	0.091***	**9.5**	0.088***	**9.2**	0.091***	**9.5**	0.088***	**9.2**
	(0.014)		(0.012)		(0.006)		(0.012)		(0.014)	
nosalt	0.702***	**101.8**	0.717***	**104.8**	0.888***	**143.1**	0.698***	**101.1**	0.568***	**76.4**
	(0.066)		(0.053)		(0.037)		(0.057)		(0.075)	
lowsalt	0.086***	**9.0**	0.090***	**9.4**	0.100***	**10.5**	0.070***	**7.2**	0.058***	**6.0**
	(0.026)		(0.020)		(0.014)		(0.020)		(0.016)	
lemonpepper	0.050**	**5.2**	0.048***	**4.9**	0.049***	**5.0**			0.042***	**4.3**
	(0.021)		(0.015)		(0.014)				(0.012)	
sweetspicy	0.042*	**4.5**	0.045***	**4.6**	0.043***	**4.4**			0.037***	**3.7**
	(0.024)		(0.015)		(0.015)				(0.012)	
ranch	0.042*	**4.3**	0.043***	**4.4**	0.045***	**4.6**			0.036***	**3.6**
	(0.024)		(0.015)		(0.015)				(0.013)	
smoked	0.034	**3.5**	0.036**	**3.6**	0.030*	**3.1**			0.029**	**2.9**
	(0.027)		(0.017)		(0.017)				(0.015)	

(*continued on next page*)

Table A3 (*continued*)

	(1) Quarter Data	Price Premium (%)	(2) Top4 Brand	Price Premium (%)	(3) DMA FE	Price Premium (%)	(4) No Flavor Covariates	Price Premium (%)	(5) Possion	Price Premium (%)
otherflavor	0.054***	**5.6**	0.050***	**5.1**	0.048***	**4.9**			0.046***	**4.7**
	(0.017)		(0.013)		(0.013)				(0.010)	
Top5Brand	−0.293***	**−25.4**			−0.292***	**−25.4**	−0.304***	**−26.2**	−0.458***	**−36.7**
	(0.091)				(0.042)		(0.082)		(0.064)	
Constant	−1.519***		−1.529***		−1.624***		−1.523***			
	(0.048)		(0.041)		(0.016)		(0.041)			
Observations	3305,396		9363,652		9363,652		9363,652		9363,652	

Notes: Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Significant premiums are in bold.

Appendix 4

Table A4
Regression results with different clustering methods

		(1) Robust	(2) Cluster: Store (adjusted for 11,761 clusters)	(3) Cluster: Product Time (adjusted for 471 clusters)	(4) Cluster: Store Product Time (adjusted for 11,761 store clusters and 471 product-time clusters)	(5) Cluster: DMA (adjusted for 201 cluster)	(6) Cluster: DMA Time (adjusted for 201 DMA clusters and 36 time clusters)
DFSF	0.226***	0.226***	0.226***	0.226***	0.226***	0.226***	0.226***
	(0.005)	(0.018)	(0.037)	(0.040)	(0.062)	(0.066)	(0.069)
MSC	0.369***	0.369***	0.369***	0.369***	0.369***	0.369***	0.369***
	(0.010)	(0.022)	(0.040)	(0.045)	(0.074)	(0.078)	(0.078)
DFSF*MSC	−0.012	−0.012	−0.012	−0.012	−0.012	−0.012	−0.012
	(0.010)	(0.024)	(0.042)	(0.047)	(0.088)	(0.086)	(0.092)
T5brands	−0.303***	−0.303***	−0.303***	−0.303***	−0.303***	−0.303***	−0.303***
	(0.004)	(0.020)	(0.034)	(0.039)	(0.076)	(0.082)	(0.082)
Small	0.789***	0.789***	0.789***	0.789***	0.789***	0.789***	0.789***
	(0.000)	(0.001)	(0.009)	(0.009)	(0.005)	(0.012)	(0.010)
Large	0.091***	0.091***	0.091***	0.091***	0.091***	0.091***	0.091***
	(0.000)	(0.001)	(0.006)	(0.006)	(0.011)	(0.012)	(0.012)
No Salt	0.698***	0.698***	0.698***	0.698***	0.698***	0.698***	0.698***
	(0.004)	(0.012)	(0.032)	(0.034)	(0.052)	(0.054)	(0.058)
Low Salt	0.090***	0.090***	0.090***	0.090***	0.090***	0.090***	0.090***
	(0.001)	(0.001)	(0.014)	(0.014)	(0.015)	(0.015)	(0.020)
Lemon Pepper	0.047***	0.047***	0.047***	0.047***	0.047***	0.047***	0.047***
	(0.001)	(0.001)	(0.014)	(0.014)	(0.006)	(0.007)	(0.015)
Sweet Spicy	0.045***	0.045***	0.045***	0.045***	0.045***	0.045***	0.045***
	(0.001)	(0.001)	(0.015)	(0.015)	(0.004)	(0.005)	(0.015)
Ranch	0.043***	0.043***	0.043***	0.043***	0.043***	0.043***	0.043***
	(0.001)	(0.001)	(0.015)	(0.015)	(0.004)	(0.006)	(0.015)
Smoked	0.035***	0.035***	0.035**	0.035**	0.035***	0.035***	0.035**
	(0.001)	(0.001)	(0.017)	(0.017)	(0.004)	(0.007)	(0.017)
Other Flavor	0.050***	0.050***	0.050***	0.050***	0.050***	0.050***	0.050***
	(0.000)	(0.001)	(0.013)	(0.013)	(0.005)	(0.010)	(0.013)
Constant	−1.523***	−1.523***	−1.523***	−1.523***	−1.523***	−1.523***	−1.523***
	(0.003)	(0.008)	(0.022)	(0.024)	(0.037)	(0.038)	(0.041)
Observations	9363,652	9363,652	9363,652	9363,652	9363,652	9363,652	9363,652

Standard errors in parentheses. All models control for product features and absorb store and year-month fixed effects. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Data availability

Data will be made available on request.

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