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Eco-labels and product longevity: The case of whitefish in UK grocery retailing

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ABSTRACT

In recent years, eco-labeling has become an increasingly used tool to signal sustainable sourcing of (sea-) food. While the literature has focused on price premiums associated with the labels, it is noted in this paper that eco-labels can also contribute to profitability by reducing cost, e.g. through longer product lifespans. Hence, eco-labels can be beneficial in a supply chain even without a price premium. This study applies duration analysis to explore whether two eco-labels (the MSC label of the Marine Stewardship Council and a line-caught label) influence product longevity of whitefish products in eight different grocery retailers in the UK. The results show that MSC labeled products have a 64.7% lower risk of being withdrawn from the shelves compared to non-MSC products, while products with the line-caught label have a 32.8% lower risk of being withdrawn than products without this label. The results also indicate that the influence of the eco-labels on product longevity vary considerably between the retailers.

1. Introduction

During the last twenty years eco-labels and certification schemes have played an increasingly important role in the seafood market (Uchida et al., 2014; Asche et al., 2015a; Lucas et al., 2018; Roheim and Zhang, 2018) as well as in food markets in general (Blend and van Ravenswaay, 1999; Onozaka and McFadden, 2011). One example is the Marine Stewardship Councils MSC label, which provides assurance to consumers regarding the environmental sustainability of the fishery from which seafood products originate.[1] Similarly, in some markets both retailers and brand manufacturers emphasize the environmental credentials and sometimes the quality associated with the fishing method/production technology applied. Examples include fisheries that are "dolphin-safe" (Teisl et al., 2002; Brown, 2012) or "line-caught" (Sogn-Grundvåg et al., 2013).

The theory indicates that the success of eco-labeled products signaling the sustainability of the production process requires that the provision of the product is profitable. Generally, this is obtained by a price premium that at least covers the costs of providing the eco-label (Gudmundsson and Wessells, 2000; Sedjo and Swallow, 2002; Roe and Sheldon, 2007). Recent studies based on hedonic price modeling and revealed preference data conducted in various seafood markets such as France, Germany, Japan, Sweden, the UK and the USA indicate that eco-labeled products obtain price premiums in most cases, but with substantial variation in the magnitude of the premium between countries, fish species and retailers, including zero premiums (Roheim et al., 2011; Sogn-Grundvåg et al., 2013, 2014; Uchida et al., 2014; Asche et al., 2015a; Blomquist et al., 2015, 2019; Asche and Bronnmann, 2017; Bronnmann and Asche, 2017; Stemle et al., 2016; Rickertsen et al., 2017; Wakamatsu et al., 2017; Alfnes et al., 2018; Lucas et al., 2018; Bronnmann and Hoffman, 2018).

Studies using alternative approaches also report mixed results. For instance, Hallstein and Villas-Boas (2013) showed that the use of a traffic-light system reduced overall seafood consumption, primarily

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[1] Gutiérrez et al., (2012) show that the status of MSC-labeled fish stocks is better than unlabeled fish stocks, although they cannot say if that is because only well-managed fish stocks have been certified or if the MSC-certification really has improved management.

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because consumption of yellow labeled fish was reduced, with no impact on green and red labeled fish. More generally, consumer knowledge about environmental issues remains limited, and Grünert et al. (2014) indicate eco-labels have limited or no impact on consumer behavior. Hence, it is far from obvious that eco-labels incentivize better management or even that the premiums associated with the eco-labeled products cover their associated cost (Roheim et al., 2018). One may therefore wonder if there are other explanations for the increased use of eco-labels.

The literature has largely focused on increased revenues to cover the cost of the ecolabel and possibly provide additional incentives for sustainable production processes. However, eco-labels can also influence markets and supply-chains in alternative ways. Recently, Roheim and Zhang (2018) forwarded and found support for the hypothesis that eco-labeled products have a lower degree of substitutability towards similar unlabeled products. As the models of Gudmundsson and Wessells (2000) and Sedjo and Swallow (2002) show, it is the increased profitability associated with the eco-label that provides incentives for its use. Hence, reducing cost will have the same potential effect as increasing revenue. In this paper we investigate whether ecolabels influence profitability in a supply chain by reducing cost through one specific mechanism – product longevity. Intense competition for shelf space leads to relatively short product life cycles for many products (Asplund and Sandin, 1999). This seemingly never-ending spiral of creative destruction implies that at least some of the substantial resources invested in product development and marketing may be expendable. An extended product life implies lower cost and more efficient use of resources (Cooper, 2012). Hence, eco-labels may play a part in the marketing strategies of retailers and national brand manufacturers in reducing cost by prolonging product life cycles.[2]

Duration analysis has seen very limited application within econometric modeling of eco-labels. However, it has been applied to examine the duration of a variety of events in a number of fields. It has, for instance, been applied to study the survival of new products in the market (Asplund and Sandin, 1999); the takeoff of new consumer durables (Golder and Tellis, 1997); individual fisherman attribution under limited-entry licensing (Smith, 2004); and also to analyze firm survival (Hannan and Carroll, 1992; Klepper, 1996; de Figueiredo and Kyle, 2006).

Our data consist of weekly personal observations of 319 different products over a period of 137 consecutive weeks starting at the end of 2010 lasting until July 2013 from Glasgow, UK. Using personal observations to collect detailed product information directly from product labels has the significant advantage over scanner data in that more detail and a complete list of available product attributes can be obtained (Ward et al., 2008; Sogn-Grundvåg et al., 2014). For example, the eco-labels focused on in this study (fishing method (line-caught) and the MSC label) are generally not available through retailer scanner data or other types of secondary data sets (Roheim et al., 2011; Sogn-Grundvåg et al., 2014). The dataset also allows examination of the influence of other product attributes such as price, country of origin and branding strategies on product longevity.

The article is organized as follows: In the next section we describe the research method. The third section describes the data and empirical specification. After this, results are presented and discussed.

2. Methods

Klepper (1996) shows how research and development costs can be regarded as fixed (and sunk), and how the unit cost is reduced with increased sales, and Cooper (2012) notes similar effects for introducing a new product in the shelves of a retailer. As a longer product cycle will normally provide higher sales than an earlier interrupted cycle, longevity will increase sales and thereby reduce cost as fixed costs are spread over more units. To the extent that there are menu costs associated with individual products, these may also be reduced by increased longevity. It is also obvious from models such as those outlined by Roe and Sheldon (2007) and Saitone et al. (2015) that any factor that lowers total cost will increase the overall welfare.

We follow Asplund and Sandin (1999) and do not specify a model that explicitly shows how longevity influences cost. However, several models of the impact of eco-labels in the market have sunk cost as an important component, like the one suggested by Roe and Sheldon (2007). In these models, the competitiveness of higher qualities will increase with higher sales as it is then easier to cover the sunk cost associated with entry to the market; as well as making the supply of eco-labeled product more likely. Asplund and Sandin (1999) note how product longevity can be regarded as a spell in the duration modeling terminology. In this study, spell is defined as the number of periods (weeks) between the entry of a product and its withdrawal from the marketplace. Thus, we aim to investigate the contribution of ecolabels and other attributes to the presence of different whitefish products on retailers' shelves. The *survival* of such products is the function:

$$S(t) = Pr(T \geq t) \tag{1}$$

where T is a random variable and denotes the length of a spell, and t is the realization of T. The survival function shows the cumulative probability that the product will last beyond t.

From the survival function one can define the hazard function (Wooldridge, 2010), which specifies the hazard rate at which a spell is completed after t periods, conditional that it has survived until t. The hazard function is formally defined as:

$$\lambda(t) = \lim_{\Delta t \to \infty} \frac{P(t \leq T \leq t + \Delta t | T \geq t)}{\Delta t} = \frac{F(t + \Delta t) - F(t)}{\Delta t S(t)} = \frac{f(t)}{S(t)} \tag{2}$$

where $F(t)$ ($=1 - S(t)$) and $f(t)$ are the cumulative probability and the probability density function of the failure function, respectively. Hence, $f(t)$ measures the probability that an observation will experience an event (e.g. exit from the market). Therefore, the hazard rate $\lambda(t)$, is a ratio between $f(t)$ (the probability of the occurrence of the event at time $T = t$) and $S(t)$ (survival until time t).

The Cox proportional hazard model is used to estimate the impact of covariates on the hazard rate. The Cox model does not specify baseline hazard and hence is not constrained by any assumed distribution of the baseline hazard function (Golder and Tellis, 1997). The Cox proportional hazard model is then:

$$\lambda(t_i) = \exp(\boldsymbol{X}_i^{'}\boldsymbol{\beta})\lambda_0(t_i) \tag{3}$$

where $\boldsymbol{X}$ is a vector of independent variables, $\boldsymbol{\beta}$ is the parameter vector, and $\lambda_0(t_i)$ is the base hazard common to all i regular spells. Generally, $\exp(\beta)$ is reported rather than the underlying parameters. $\text{Exp}(\beta_j)$ represents the ratio of two hazards, different only by a unit value of variables (X_j) (Burton et al., 2003). For the estimated $\text{Exp}(\beta_j)$, a value of 1 implies no impact of the variable on the hazard; a value of less than 1 implies a reduced hazard (longer duration) due to changes in the value (from 0 to 1 for a dummy coding). Conversely, values greater than 1 imply enhanced hazard rates (shorter duration).

A common feature of data used in duration analysis is censoring, implying that some spells may begin before and/or end after the sample period. In the literature, the hazard rate (and survival function) is estimated by using the Kaplan-Meier estimator, which is robust to censoring (Bojnec and Fertő, 2012). Thus, this approach is adopted here.

[2] It is worthwhile to not that there is no reason to expect any correlation between the price level or price premium and product longevity. For instance, the Copper river salmon as discussed in Jardine et al. (2014) receive a significant premium on an already high-priced product (king salmon), despite a short fishing season, in common with many other seasonal high value products.

3. Data

The dataset used for the empirical application was constructed from personal observations of selected whitefish products sold in eight retailers in Glasgow, UK representing the following eight grocery retailers: Asda, Co-op, Lidl, Marks & Spencer (M&S), Morrisons (MORS), Sainsbury's (SAIN), Tesco (TESC), and Waitrose (WAIT).[3] The whitefish species included are Atlantic cod, haddock, and Alaska pollock. The weekly observations span from November 1, 2010 to July 14, 2013, covering a period of 137 consecutive weeks. A trained assistant collected the data. First, all chilled pre-packed and frozen products were purchased, and the front and back sides of the packs were photographed. Fresh fish fillets displayed in wet fish counters were photographed on site with the consent of shop staff. Data on product attributes were taken directly from the photos. During the weekly store visits, the assistant surveyed the fresh fish counter, the frozen and chilled cabinets for product additions or deletions within the selected product categories and species. Prices for all products were noted on each store visit. During the sample period, a total of 122 cod products, 160 haddock products and 37 Alaska pollock products were observed. Table 1 shows the number of products by species and attributes.

The use of ecolabels varies by species. For cod, the share of line-caught products is about 29.5%, which is much higher than the share of MSC labeled cod products (11.5%). This is also true for haddock where 37.5% of products are line-caught and 19.4% are MSC labeled products. For Alaska pollock, there are only three line-caught and two MSC-labeled products (out of 37 products). The low share of MSC labeled Alaska pollock products indicates that most of these products do not originate from the U.S., which is the only Alaska pollock fishery that was certified by the Marine Stewardship Council during the sample period (The Russian Alaska pollock fishery was granted MSC certification as of the 24th September 2013, which was after our sample period).[4] There is also a possibility that retailers refrain from using the MSC logo in spite of the fishery being certified, as exemplified by South African hake and Swedish cod where Lallemand et al. (2016) and Blomquist et al. (2015) report that only a portion of the landings are sold with the on-pack logo. There are far more products with private labels (2 3 6) than with national brands (83).

3.1. Retailer heterogeneity

The lower rows in Table 1 show the distribution of the three whitefish species across the eight retailers. Haddock is the main species sold in all outlets except for Lidl and Tesco, where cod is the main whitefish species. Asda and Morrisons account jointly for 54.1% of all Alaska pollock products, indicating a low-price positioning for these two retailers, in line with previous research (Burt et al., 2010; Asche et al., 2015a). Table 2 shows how product attributes are distributed across the retailers.

Table 2 reflects substantial variation in the number of attributes of whitefish products across the retailers. For example, fresh whitefish appears to be more prevalent in Asda, Morrisons, Sainsbury's, and Waitrose. In Asda, Morrisons, Sainsbury's and to a lesser extent in Tesco, several high-quality loin products (the thickest and most valuable part of a fillet) are sold. In combination, Asda and Morrisons offer about half of the smoked whitefish products. Line-caught whitefish products are common in all retailers except for Co-op and Lidl, which were observed to carry only two line-caught products in the study period. The MSC label is seemingly absent in Morrisons, Tesco and Waitrose whereas Sainsbury's held a dominant position with almost 60% of the 47 MSC labeled whitefish products on display; followed by nine and seven products in Co-op and Asda, respectively. Sainsbury's and Asda are the only two retailers offering both line-caught and MSC labeled products.

Table 1
Number of products, by species and attributes.

Species	Cod	Haddock	Alaska Pollock	Sum
Total	122	160	37	319
Conservation				
Fresh	17	37	3	57
Chilled	45	81	3	129
Frozen	60	42	31	133
Cuts				
Loins	24	14	0	38
Other	98	146	37	281
Smoked or not				
Smoked	18	79	2	99
Other	104	81	35	220
Value-added 1				
Ingredients	33	26	9	68
No ingredients	89	134	28	251
Value-added 2				
Boneless/Skinless	10	21	0	31
With bone and skin	112	139	37	288
Fillets				
Butterfly fillets	0	15	0	15
Other	122	145	37	304
Weight				
Individual	40	80	8	128
Fixed	82	80	29	191
On promotion				
Promotion	13	14	2	29
No promotion	109	146	35	290
Catch methods				
Line-caught	36	60	3	99
Other	86	100	34	220
MSC – Labeling				
MSC	14	31	2	47
Non–MSC	108	129	35	272
Brand				
Private labels	89	125	22	236
National brands	33	35	15	83
Country-of-origin				
Scottish	1	13	0	14
Other	121	147	37	305
Retailer				
Asda	20	33	10	63
Co-op	7	14	4	25
Lidl	7	5	2	14
M&S	11	18	0	29
MORS	23	34	10	67
SAIN	18	21	5	44
TESC	27	19	4	50
WAIT	9	16	2	27

3.2. Product duration

Table 3 shows the mean duration for all species and retailers for the full sample, with and without the MSC and line-caught labels.

[3] Shorter versions of this data set have also been used to investigate the presence of price premiums for whitefish (Sogn-Grundvåg et al., 2013, 2014). Asche et al. (2015) also use data from this data collection program, but for salmon, a primarily farmed species.

[4] There are also other ecolabels used, like Friends of the Sea. However, the MSC label is by far the most used. Our data collection method provides us with information on all labels. This justifies the approach taken in the larger literature in focusing on the MSC label, as this is the by far the most used label. While Friends of the Sea labels appear in the data, there are so few products (8 for haddock and 6 for cod) that use it and it is statistically insignificant when one try to control for it in Model Ia. Hence, products with the Friends of the Sea label are treated as unlabeled in the empirical analysis.

Table 2
Number of whitefish products, by retailers and attributes.

Outlet	Asda	Co-op	Lidl	M&S	MORS	SAIN	TESC	WAIT	Sum
Total	63	25	14	29	67	44	50	27	319
Species									
Cod	20	7	7	11	23	18	27	9	122
Haddock	33	14	5	18	34	21	19	16	160
Alaska Pollock	10	4	2	0	10	5	4	2	37
Conservation									
Fresh	17	0	0	0	19	10	1	10	57
Chilled	22	14	3	15	26	19	23	7	129
Frozen	24	11	11	14	22	15	26	10	133
Cuts									
Loins	8	0	1	3	9	6	9	2	38
Other	55	25	13	26	58	38	41	25	281
Smoked or not									
Smoked	25	9	2	10	21	13	12	7	99
Other	38	16	12	19	46	31	38	20	220
Value-added 1									
Ingredients	7	5	6	9	17	6	14	4	68
No Ingredients	56	20	8	20	50	38	36	23	251
Value-added 2									
Boneless/Skinless	0	4	2	4	8	7	6	0	31
With bone and skin	63	21	12	25	59	37	44	27	288
Fillets									
Butterfly fillets	7	1	0	0	3	4	0	0	15
Other	56	24	14	29	64	40	50	27	304
Weight									
Individual	27	7	1	6	32	21	19	15	128
Fixed	36	18	13	23	35	23	31	12	191
On promotion									
Promotion	2	1	0	1	6	10	9	0	29
No promotion	61	24	14	28	61	34	41	27	290
Catch methods									
Line-caught	10	2	2	10	23	15	17	20	99
Other	53	23	12	19	44	29	33	7	220
MSC – Labeling									
MSC	7	9	1	3	0	27	0	0	47
Non–MSC	56	16	13	26	67	17	50	27	272
Brand									
Private label	43	13	1	29	49	35	41	25	236
National brands	20	12	13	0	18	9	9	2	83
Country-of-origin									
Scottish	5	0	3	3	1	1	0	1	14
Other	58	25	11	26	66	43	50	26	305

Table 3
Mean of spell length (weeks) of products with and without ecolabels, by species and retailers.

	Full sample	MSC-labeled	Non MSC	Line-caught	Other catching methods
All products	48.6	44.8	49.3	55.4	45.4
Species					
Cod	46.5	22.4	49.9	51.7	44.0
Haddock	51.3	53.8	50.7	57.2	47.7
Pollock	43.8	75.5	42.1	69.0	41.7
Retailer					
Asda	60.3	112.1	54.5	60.1	60.4
Co-op	45.3	48.6	43.5	6.00	48.5
Lidl	62.1	136.0	56.5	49.0	64.3
M&S	77.4	64.6	79.5	93.8	68.8
MORS	55.0		55.0	65.5	48.8
SAIN	21.9	20.9	23.7	28.4	18.1
TESC	23.9		23.9	37.1	17.3
WAIT	52.2		52.2	59.5	30.5

Inspection of Table 3 shows that the average spell length for the full sample (319 products) is 48.6 weeks. This is substantially lower than the 137-week sample period, indicating a rather low survival rate and suggesting an ongoing dynamic level of churn within the seafood sector. This is not surprising given the results with respect to product introduction in general provided by Asplund and Sandin (1999). The three species have relatively similar survival rates but cod and haddock products last somewhat longer than Alaska pollock. There is substantial variation in average product longevity between the different retailers – varying between 77.4 weeks for the high-end retailer Marks & Spencer and only 21.9 weeks for Sainsbury's.

Table 3 also shows the average longevity for products with and without ecolabels across species and retailers. In aggregate terms, products without the MSC-label have a slightly longer survival (49.3 weeks) than products with the label (44.8 weeks). However, this result masks some substantial and interesting differences across species and retailers. For example, MSC-labeled products of Alaska Pollock (75.5 weeks) stay on shelves more than three times longer than MSC-labeled cod (22.4 weeks). Moreover, MSC-labeled cod stayed much shorter (22.4 weeks) than non-MSC labeled cod (49.9 weeks). For

Alaska Pollock the opposite is the case with MSC labeled products (75.5 weeks) staying much longer than non-MSC labeled products (42.1 weeks).

What about spell-lengths for MSC-labeled whitefish across the eight retailers? Table 3 shows large and interesting variations between the retailers. For instance, MSC-labeled products survive much longer in Lidl (136 weeks) than in Sainsbury's (20.9 weeks). It can also be seen that for three of the retailers (Asda, Lidl and M&S) the average product survival with the MSC label is much longer than without the label. Further, for all the five retailers carrying MSC-labeled products the survival rate is longer with the label than without the label.

Table 3 also shows that products with the line-caught label had an average survival of 55.4 weeks compared to 45.4 weeks for products without the label. The line-caught label also shows longer average product survival (55.4 weeks) than MSC-labeled products (44.8 weeks). Regarding species, results are very similar for products carrying the line-caught label, which survives somewhat longer than products without the label. However, the results show large variation for the line-caught label across the different retailers. For example, products with the line-caught label survive substantially longer in M&S (93.8 weeks) than in other retailers. For six of the retailers, products with the line-caught label survive longer than for products without the label. Nevertheless, for the remaining two – Co-op and Lidl – the opposite is the case. It should, however, be noted that these two retailers only carried two line-caught products each within the sample period.

Seasonality in landings and therefore product availability can be a challenge for fish as the supply of any product that depends on a given fishery may be interrupted when the fishery stops. However, while this is a prevalent issue in upstream markets, it is less likely to be a challenge downstream at the retail level in modern supply chains. In particular, it is not much of a challenge for more conserved products like frozen fish and chilled fish, which is mainly based on frozen product that is refreshed or thawed. In principle, the conservation process itself can limit the impact of supply shocks, and suppliers typically give themselves more flexibility by not associating the product with any specific fishery. On the packages in our dataset origins such as Atlantic or north-east Atlantic is more common than any specific country. Supply shock can potentially be more of an issue for a perishable commodity like fresh fish, but also here there exist numerous sources as e.g. fresh cod is landed daily in Iceland as well as in Norway throughout the year (Asche et al., 2015b; Knútsson et al., 2016; Landazuri-Tveteraas et al., 2018). Hence, well integrated fish markets with global sourcing largely make availability independent of the sourcing from any specific fishery even for fresh fish (Anderson et al., 2018). Our data set also indicates that this is not a challenge as the significant variation in product longevity between retailers is an indication that seasonality in production does not matter much.

Our results are, of course, only describing the seafood market in Glasgow. An important question is whether the results are applicable more generally. National pricing strategies are the norm in U.K. grocery retailing (Lan and Dobson, 2017; Lloyd et al., 2014), indicating that the results may be applicable for the UK at large. However, there is also some evidence of regional consumer preferences for different species and attributes that may cause some differences in stocking. For example, Roheim et al. (2011) found that the retail market for frozen seafood in two different regions (London metropolitan area and the Lancashire area) had different valuations of several attributes. This indicates that the valuation of attributes may also vary across the country. Still, the demographic and cultural mix of the Glasgow population is sufficiently varied to reflect, to a large extent, the national variation. In addition, ad hoc checks were made of the products when visiting these stores elsewhere in the United Kingdom, and these revealed no significant deviation in the product mix offered. The results do, of course not, say anything about product longevity in other markets. However, the fact that longevity for ecolabeled products increases in a statistically significant manner, as shown in our results section, does suggest that cost reductions due to longevity may help explain why ecolabeled products are stocked even when price premiums are low or non-existent, answering at least partly some of the criticism against seafood ecolabels (Roheim et al., 2018).

4. Empirical specification

With the exception of price, all variables are expressed as dummy variables in the specification. For each attribute, there is a base category and the remaining types are dummy variables with a value of one for observations (products) with the characteristics. The base product is Alaska pollock with the following characteristics: sold in Waitrose, frozen, not loin, not smoked, not containing ingredients, with bone and/or skin, not butterfly fillets, fixed weight, not line–caught, not MSC labeled, has a national brand, not Scottish origin, and is without promotion. Finally, the Cox model is specified by taking the logarithm of Eq. (3) and replacing the variable vector with the price and dummy variables. This gives the equation:

$$\log(\lambda_i) = a_1 Price_i + b_1 Cod_i + b_2 Haddock_i + c_1 Fresh_i + c_2 Chilled_i + d_1 Loins_i + e_1 Smoked_i + f_1 Ingredients_i + g_1 Boneless/Skinless_i + h_1 Butterfly_{fillets_t} + i_1 Weight(individual)_i + j_1 Line_{caught_i} + k_1 MSC_i + l_1 Priviate_{labeli} + m_1 Scottish_i + n_1 Promotion_i + o_1 Asda_i + r_1 CO_{op_i} + r_3 Lidl_i + r_4 M\&S_i + r_5 MORS_i + r_6 SAIN_i + r_7 TESC_i + t_1 Spells + U_i, \quad (4)$$

where all variables are listed in Tables 2 and 3, with the exception of dummy *Spells*. During the sample periods, some products experienced multiple spells potentially due to seasonality of fish products or other supply chain issues.[5] Following Besedeš and Prusa (2006), the dummy variable *Spells* is incorporated in the specification to test the differences between products with multiple spells and other products. *Spells* is set to one for products with multiple spells, and zero for other products.

According to De Figueiredo and Kyle (2006), product longevity is a function of a product's position within a market and its position in the product portfolio of the firm (i.e., the retailer or a national brand manufacturer). Furthermore, they argue that product exit is a result of low sales, low margins and/or strategic product portfolio decisions where managers for instance may withdraw successful products in order to make way for a new model. This indicates that the impact of ecolabels on product longevity may vary across retailers and of course may vary due to (undeclared) policy changes over time, possibly within the sample period. In order to account for retailer heterogeneity, interaction terms between retailers and sustainability labels (*MSC* and *Line-caught*) are added to the base model in Equation (4).[6] This leads to three models to be estimated, i.e.:

Regression Ia, Equation (4), base model;
Regression Ib, Equation (4) with interaction terms between retailers and *MSC*;
Regression Ic, Equation (4) with interaction terms between retailers and *Line-caught*;
Regression Id, Equation (4) with interaction terms between retailers and *Line-caught* and between retailers and *MSC*.

[5] Price may influence product longevity creating a potential endogeneity problem. However, when investigated using the approach of Wulfsohn and Tsiatis (1997), no indications of endogeneity of the price were found.

[6] A number of other interactions are also possible. We estimated versions of Eq. (4) allowing for interaction between MSC and line caught, between MSC and the conservation forms chilled and fresh, and an interaction term between MSC and the species cod and haddock to allow for different premiums for the three species. In all cases, these interaction terms are statistically insignificant and these models are therefore not reported.

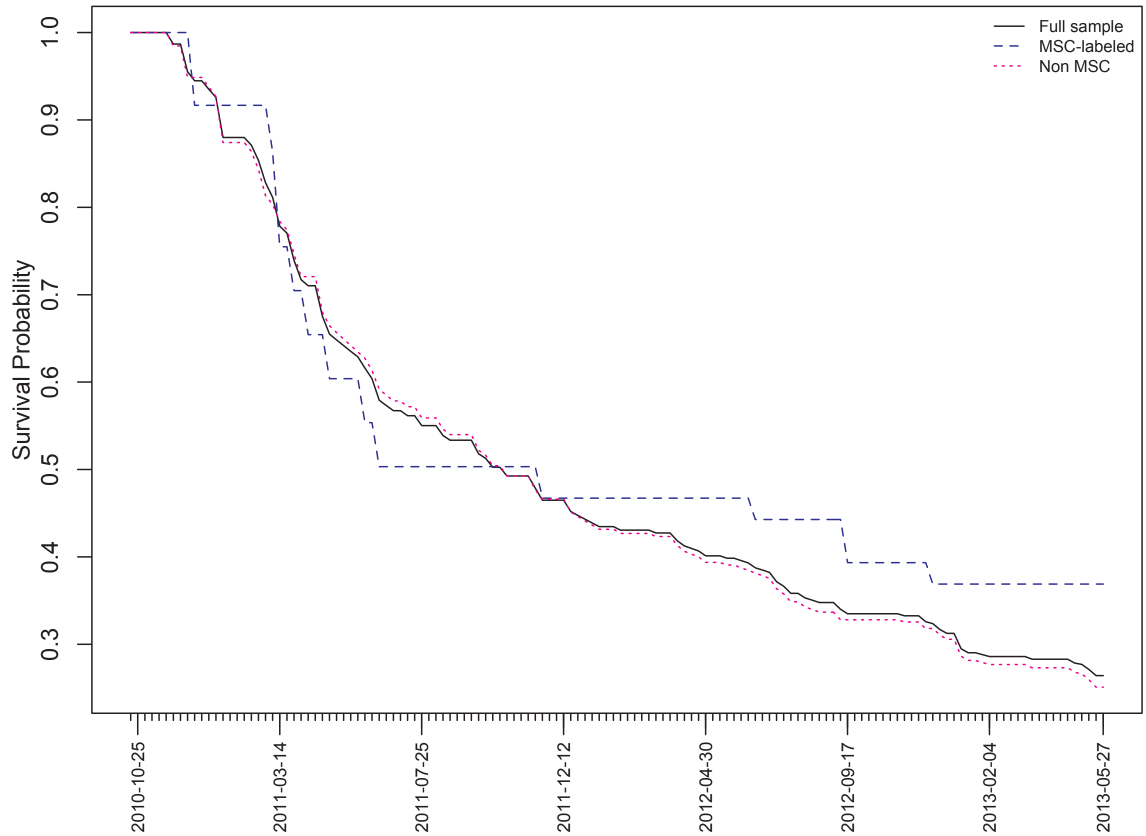

Fig. 1. Empirical Kaplan-Meier Survival Functions for MSC-labeled and Non MSC Whitefish.

For comparison, the ordinary least square (OLS) estimation with spell-length as the dependent variable is also estimated. This is:

Regression II, Equation (4) but with spell–length as the dependent variable.

5. Results

We first employ the Kaplan-Meier method to estimate the survival function. Different from the calculated duration times in Table 3, the survival function is modeled as a sequence of conditional probabilities that the product will remain beyond week *t*, given that it has already survived *t* periods. We estimate the survival function for the full sample, and for products with the MSC and line-caught labels. For individual retailers and species, the number of eco-labeled products is too small, and we shall shed light on this heterogeneity using interaction terms between retailers/ species and the two ecolabels.

Fig. 1 presents the estimated survival probabilities for MSC-labeled and non-MSC products. Inspection of Fig. 1 shows that after August 2011, survival probabilities for MSC-labeled and non-MSC labeled products deviated substantially from each other with a higher survival probability for MSC-labeled products. For catch methods, Fig. 2 shows that for most of the period, line-caught products have a higher survival probability than products without this label. However, other product attributes may also influence the survival rates of these products. Thus, we turn to the Cox model in order to isolate the impact of ecolabels on products' hazard rates.

Tables 4 and 5 report the estimation results of the Cox models (regressions Ia - Id). As noted above, if the coefficient in Cox-regressions Ia – Id takes on values greater than 1, changes in the corresponding variables increase the hazard rate of the product, controlled for the influence of all other variables included in the regression. Hence, the reported significance level for a particular coefficient is for the null hypothesis that the relevant attribute has no impact on the hazard rate facing the product with this attribute, *ceteris paribus*. Model diagnostics show that, for each model, the null hypothesis of joint insignificance of all variables is rejected by the log-likelihood test and the Wald test. Moreover, tests for the proportional-hazards assumption provide evidence of proportional hazards for the model as a whole and for most of the significant covariates. Considering the censoring issue, we also estimated the models using only the non-censored observations. The results are not qualitatively different from those estimated from the models using the full sample. Thus, reported results are for the full sample.

5.1. The base model

The results for regression Ia in Table 4 show that products of cod and haddock encounter a substantially higher risk of withdrawal compared to the base product (Alaska pollock), as indicated by the larger values for *Cod* (1.886) and *Haddock* (2.363). The larger coefficient for haddock than for cod implies shorter survival rates for haddock products.

Interestingly, Table 4 also shows that the coefficient of the price is 0.907, indicating that a more expensive product has slightly longer longevity than a cheaper product. More precisely, a one-pound price increase would reduce the hazard rate by about 10%. Several of the search attributes are important. While *Chilled* and *Boneless / Skinless* products have a high risk of withdrawing from the market, attributes like *Smoked* and *Ingredients* prolong product lifetimes.

The insignificant estimate for *Scottish* origin indicates that products labeled with Scottish origin do not stay longer on the shelves compared with other origins. However, the estimates for Line-caught, Private Labels and MSC are statistically significant with coefficients between 0.353 and 0.672, implying that these attributes all contribute to prolonged product lifetimes. The low coefficient for MSC (0.353) implies

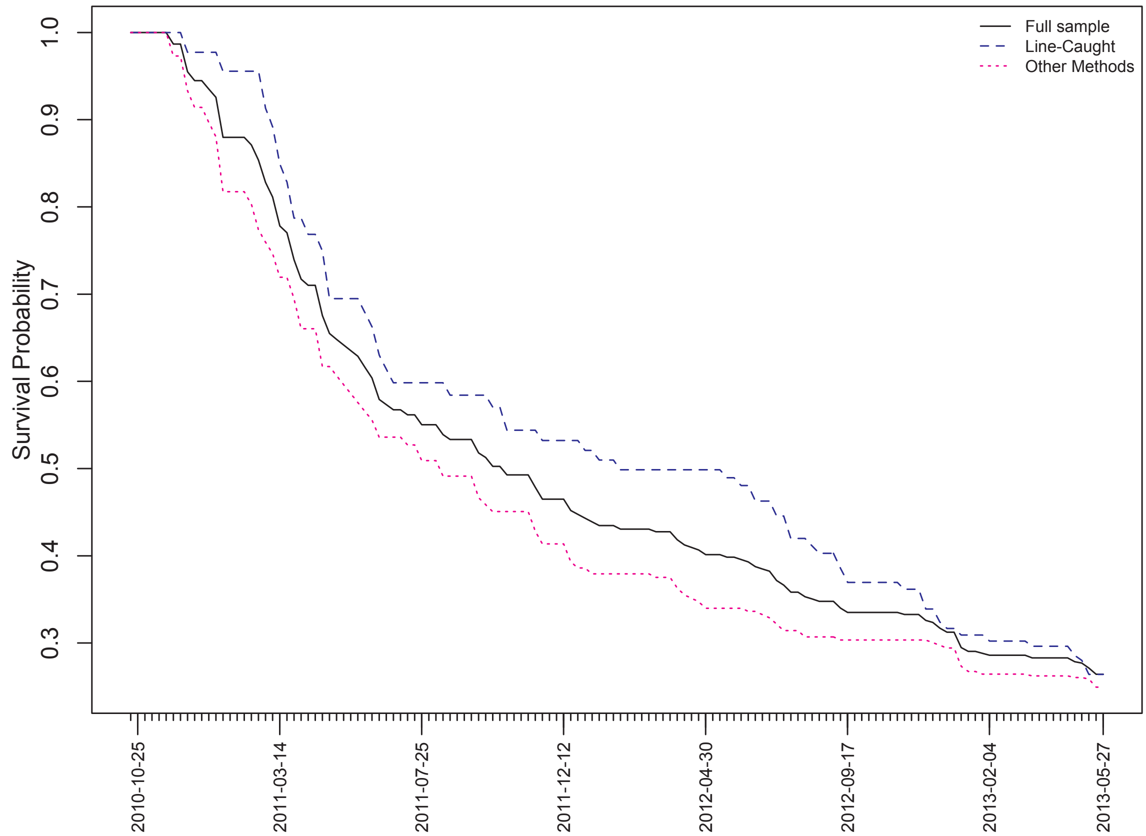

Fig. 2. Empirical Kaplan-Meier Survival Functions for Line-caught and other catch methods for Whitefish.

that MSC-labeled products have a 64.7% (= (1 − 0.353) × 100%) higher probability for staying on the shelves than products without the MSC label. Products with the line-caught label have a 32.8% higher probability of staying in the market than products without the label. Private labeled products have a 43.4% higher probability for staying on the shelves than products with national brands. This indicates that national brand manufacturers introduce more new products than retailers do, which leads to higher product turnover for national brands.

In the UK, as in most developed countries, different types of sales promotions are commonly applied by retailers (Lan et al., 2015). The coefficient for *Promotion* is statistically significant but only marginally lower than 1 (0.951), indicating only a weak positive impact of promotion on product longevity. The significant multiple spell dummy indicates that products with non-continuous appearances have a shorter duration than products without spell breaks. This is also in line with the findings in Besedeš and Prusa (2006).

Finally, we turn to retailer dummies, which reveal retailer heterogeneity in terms of different hazard rates for the whitefish products included in the sample. Compared to Waitrose (the base retailer) whitefish products sold in the Co-op, Lidl, and Morrisons have a substantially lower probability for withdrawal. Hence, not only do premiums vary by retailer as reported by Asche et al. (2015a), but the also the longevity of a product. It should be noted that the market shares of Co-op and Lidl are smaller than that of Waitrose. On the other hand, the hazard rates of whitefish supplied in Asda, Sainsbury's, Marks & Spencer, and Tesco – all with larger market shares than Waitrose – are not different from Waitrose. This suggests that these retailers with smaller market shares keep their whitefish products longer on their shelves. We now turn to the various influences of ecolabels on product longevity across retailers and species.

5.2. The models with interaction terms

Regressions Ib and Ic Tables 4 and 5 test retailer heterogeneity regarding the impacts of MSC-labeling and line-caught labeling. To avoid multicollinearity and further obtain convergent results, only retailers with a sizable number of products (> 3 products) have the interaction dummies. Accordingly, there are interaction dummies between three different retailers and *MSC* and between six retailers and *Line-caught*. In regression Ib, two interaction terms, *Asda*: *MSC* and *Co-op*: *MSC* are significant, while *SAIN*: *MSC* is insignificant, indicating that the impact of MSC-labeling on product longevity is different between retailers. The relative hazard rates for *Asda*: *MSC* and *Co-op*: *MSC* are much lower than the average hazard rate of MSC-labeled products for all the retailers in the sample (0.353 in regression Ia). This is not unexpected as the average hazard rate in regression Ia captures both the significant impacts of MSC-labeling in Asda, the Co-op and the insignificant impact of MSC-labeling in Sainsbury's.

In regression Ic, four of the six interaction dummies are significant. Line-caught products sold in Morrisons and Tesco do not have a lower risk of withdrawal than the base product without the line-caught label. The significant estimates show that line-caught products in Sainsbury's (*SAIN*: *Line-caught*) has a very high hazard rate (3.003) compared to the results for the whole sample (0.672 in regression Ia). Thus, neither the MSC nor line-caught labels contribute to reduced hazard rates for products sold in Sainsbury's. By contrast, Asda is the only retailer where both MSC and line-caught products are more likely to stay longer on the shelves. For Marks & Spencer, the coefficient of *Line-caught* is 0.156, implying a very low hazard rate. The longevity of line-caught haddock in Marks & Spencer indicates that the marketing strategy with a strong focus on sustainability provides considerable net benefits to the retailer.

As there are statistically significant interaction terms in regressions Ib and Ic, this suggests an omitted variable problem in both models. Model Id is therefore estimated with both sets of interaction terms. The

Table 4
Cox model estimation (Ia and Ib).

	Ia		Ib	
Variable	Coef.	SE	Coef.	SE
Price	0.907**	[0.042]	0.906**	[0.042]
Cod	1.886*	[0.341]	1.973**	[0.340]
Haddock	2.363**	[0.364]	2.431***	[0.363]
Fresh	1.088	[0.409]	1.149	[0.411]
Chilled	1.848*	[0.332]	1.869*	[0.335]
Loins	0.773	[0.382]	0.755	[0.384]
Smoked	0.665**	[0.207]	0.64**	[0.210]
Ingredients	0.527**	[0.277]	0.542**	[0.276]
Boneless/Skinless	1.713*	[0.312]	1.571	[0.319]
Butterfly-fillets	1.107	[0.433]	1.270	[0.434]
Individual weight	0.832	[0.258]	0.926	[0.255]
Promotion	0.951***	[0.011]	0.948***	[0.012]
MSC	0.353***	[0.342]		
Line-caught	0.672*	[0.225]	0.674*	[0.226]
Private labels	0.434***	[0.282]	0.396***	[0.290]
Scottish	0.584	[0.465]	0.853	[0.486]
Asda	0.642	[0.386]	0.700	[0.390]
Co-op	0.380*	[0.516]	0.465	[0.523]
Lidl	0.193***	[0.675]	0.141***	[0.679]
M&S	0.541	[0.403]	0.473*	[0.413]
MORS	0.479**	[0.368]	0.462**	[0.370]
SAIN	1.666	[0.429]	1.026	[0.533]
TESC	1.173	[0.407]	1.190	[0.408]
Spells	2.716***	[0.217]	2.354***	[0.219]
Asda: MSC			0.080**	[1.080]
Co-op: MSC			0.145*	[1.128]
SAIN: MSC			0.907	[0.566]
Log likelihood value	126.0		129.2	
R^2	0.305		0.312	

Notes: ***, ** and * denote the significance at the 1%, 5%, and 10% levels, respectively.

Table 5
Cox Model (Ic and Id).

	Ic		Id	
	Coef.	SE	Coef	SE
Price	0.896***	[0.042]	0.897***	[0.042]
Cod	2.276**	[0.358]	2.417**	[0.354]
Haddock	2.892***	[0.374]	2.861***	[0.372]
Fresh	1.195	[0.412]	1.185	[0.415]
Chilled	2.031**	[0.332]	1.960**	[0.339]
Loins	0.868	[0.392]	0.834	[0.393]
Smoked	0.711*	[0.21]	0.687*	[0.215]
Ingredients	0.459***	[0.276]	0.498***	[0.277]
Boneless/Skinless	1.651	[0.318]	1.539	[0.325]
Butterfly-fillets	1.142	[0.433]	1.234	[0.435]
Individual weight	0.815	[0.273]	0.914	[0.273]
Promotion	0.946***	[0.011]	0.945***	[0.012]
MSC	0.203***	[0.393]		
Line-caught				
Private labels	0.370***	[0.292]	0.369***	[0.297]
Scottish	0.538	[0.454]	0.771	[0.472]
Asda	0.418*	[0.537]	0.461	[0.54]
Co-op	0.232**	[0.615]	0.273***	[0.628]
Lidl	0.085***	[0.739]	0.073***	[0.737]
M&S	0.547	[0.601]	0.360*	[0.613]
MORS	0.250***	[0.534]	0.258***	[0.535]
SAIN	0.490	[0.671]	0.451	[0.681]
TESC	0.383	[0.611]	0.425	[0.613]
Spells	2.864***	[0.231]	2.486***	[0.233]
Asda: Line-caught	0.255**	[0.688]	0.275*	[0.688]
M&S: Line-caught	0.156***	[0.679]	0.266**	[0.676]
MORS: Line-caught	0.676	[0.369]	0.703	[0.366]
SAIN: Line-caught	3.003*	[0.639]	1.939	[0.750]
TESC: Line-caught	1.918	[0.479]	1.812	[0.479]
WAIT: Line-caught	0.325**	[0.562]	0.347**	[0.56]
Asda: MSC			0.078***	[1.084]
Co-op: MSC			0.132*	[1.127]
SAIN: MSC			0.463	[0.713]
Log likelihood value	145.4		141.4	
R^2	0.343		0.335	

Notes: ***, ** and * denote the significance at the 1%, 5%, and 10% levels, respectively.

results in model Id is very similar to Ib and Ic, with the same terms being statistically significant and with similar magnitude on the estimated parameters. This suggests that the interaction terms are uncorrelated, and there is no significant omitted variable bias in Models Ib and Ic.

5.3. OLS-estimation

Table 6 presents the results from the OLS estimation (regression II). This is a good exercise to test how covariates affect duration times directly. Intuitively, the product attributes may have a direct influence in the spell-time. The estimation results show that, except for the species dummies, all significant coefficients in the base model (Ia) are significant for the corresponding variables in regression II. Moreover, the variables with lower hazard rates (coefficient < 1) are positively related to the duration times, and the converse for the variables with higher hazard rates. For example, the MSC and line-caught labeled products extend the product lifetime by about 19 and 18 weeks, respectively. However, caution must be taken when comparing the results of the Cox model and the OLS regression, as the censoring issue in the dataset may bias the OLS estimator (Jenkins, 1995).

6. Discussion

The impacts of seafood ecolabels are controversial. The original model for the sustainable seafood movement, whereby consumers preferring sustainably produced seafood signal their preference with an increased willingness to pay for ecolabels thus creating a profit incentive for producers, at best works only partially (Roheim et al., 2018). There is substantial evidence for the existence of price premiums for many, but not all, sustainably sourced seafood products and for ecolabeled products in general. However, there is also significant discussion with respect to the effect of the premiums. In addition to evidence of small and absent premiums in some cases, questions also exist as to whether consumers are well informed about specific ecolabels or indeed care sufficiently to acquire further information or warrant its provision (Grünert et al., 2014). Moreover, it is highly unclear whether the premiums from the certification schemes actually transmit along supply chains from retailers to producers (Stemle et al., 2016; Blomquist et al., 2019)[7]; and thereby create incentives for more sustainable fishing.

Nonetheless, the number of fisheries certified, the number of ecolabels that producers can choose between and products sold with an ecolabel has risen rapidly in recent years (Alfnes et al., 2018; Roheim et al., 2018; Amundsen et al., 2019). This has led to several alternative explanations as to why ecolabels are popular (Roheim et al., 2018). These vary from positive perspectives suggesting that the ecolabel, even without a price premium, encourages more sustainable production practices such as functioning as a risk management tool, to more

[7] Moreover, while there is evidence that MSC-labeled fish stocks are in better shape, one cannot say whether the status of ecolabeled fisheries are better because the ecolabel has led to improved management, or whether it is primarily well managed fisheries that has been certified with little change in actual management systems. Sampson et al (2015) shows in the case of Fisheries Performance Projects (FIPs) that in a large number of cases, there were no change in management.

Table 6
OLS estimation (II).

	II	
	Coef	SE
Intercept	18.637	[12.52]
Price	1.523**	[0.753]
Cod	−6.319	[7.023]
Haddock	−7.763	[7.343]
Fresh	−15.98**	[8.005]
Chilled	−17.701***	[6.132]
Loins	12.659*	[7.039]
Smoked	3.014	[4.453]
Ingredients	6.804	[5.373]
Boneless/Skinless	−8.315	[6.742]
Butterfly-fillets	16.712*	[9.526]
Individual weight	14.158***	[5.541]
Promotion	1.237***	[0.132]
MSC	19.122***	[6.856]
Line-caught	18.704***	[5.103]
Private labels	9.211*	[5.73]
Scottish	19.015**	[9.583]
Asda	4.654	[8.567]
Co-op	1.674	[10.413]
Lidl	30.440**	[13.609]
M&S	18.612**	[9.345]
MORS	14.652*	[8.328]
SAIN	−35.909***	[9.583]
TESC	−25.674***	[8.829]
Spells	−23.19***	[5.531]
R^2	0.397	

Notes: ***, ** and * denote the significance at the 1%, 5%, and 10% levels, respectively.

cynical observations opining that the proliferation of ecolabels reflects a race to the bottom where retailers claim ‘sustainability kudos’ but with the least rigorous and cheapest label possible. What are the actual workings of the labels then becomes an empirical question. The results in this paper complement those of some other recent studies through supporting evidence that the ecolabel can promote outcomes manifest in dimensions other than price. For instance, Zhang et al. (2018) provide evidence that ecolabels change substitution patterns and Amundsen and Osmundsen (2019) show that the certification process increases production efficiency.

The fact that there is increasing evidence of positive impacts of ecolabels unrelated to a price premium is important; it provides supplementary and alternative explanation for their continued and more widespread adoption by firms. Amundsen et al. (2019) observe that various ecolabels have different foci and impacts.[8] This can provide a partial justification for the multitude of labels available: labels vary in their effect and so may be selected according to the specific element targeted in the value chain. Hence, a firm’s choice may incorporate decisions about the product being produced, the target market(s) *inter alia*. From a sustainability perspective, one somewhat disconcerting implication is that this may provide incentives to use ecolabels that are completely unrelated to the production process; a factor which is likely to extend ongoing discussion about the usefulness and impacts of ecolabels more generally.

7. Conclusions

While increased revenue associated with an ecolabel has been perceived to be the main approach to cover the increased cost associated with the labeling (Roheim et al., 2018), little focus has been given to the fact that ecolabels may also reduce costs in the supply chain.[9] In this article, we investigate whether eco-labeled products have longer lifecycles, which may reduce menu costs and product development costs. This can provide incentives for using an ecolabel even if there is no explicit price premium associated with the ecolabel.

Product longevity is investigated for three seafood species in eight retailers in Glasgow, UK. The results show that the MSC and line-caught labels prolong product lifetimes significantly. After controlling for the influence of other variables included, MSC labeled products have a 64.7% lower risk of being withdrawn from the shelves compared to non-MSC products. Products with the line-caught label have a 32.8% lower risk of being withdrawn than products without this label. This is a strong indication that these ecolabels contribute net benefits to the retailer and/or in the supply chain in the form of lower product development and possibly lower menu costs.

The results may at least partially explain why eco-labeled products are stocked even when price premiums are low or non-existent, as found for Alaska Pollock in Germany (Asche and Bronnmann, 2017) and other markets. It also supports the results of Roheim and Zhang (2018), who report that competition is weakened for eco-labeled products as the cross-price elasticities are reduced, as the longer product longevity may be a mechanism for the reduced substitutability. These results shed some light on why the number of certified fisheries continues to increase rapidly despite the mixed evidence with respect to the existence of price premiums to cover costs, as there are other benefits with ecolabels that reduce costs. However, from a sustainability perspective this insight is problematic in that the use of ecolabels can be justified based only on gains in the supply chain downstream from the producer, and as such, the ecolabel does not need to lead to more sustainable production processes.

Our findings also show that the influence of the two ecolabels on product longevity varies considerably between the retailers. For Marks & Spencer, a retailer with a particular focus on sustainability, the line-caught products have the lowest risk of withdrawal among all retailers in the sample. That some retailers keep products with eco-labels much longer on the shelves indicates different management perceptions regarding the value of ecolabels but also viable opportunities for product differentiation, which may lead to more sustainable and effective resource use along the value chain.

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[8] This is, of course, not surprising as sustainability also have a number of dimensions (Asche et al., 2018).

[9] Innovations in the supply chain are a key element in the development of the seafood market in recent decades, of which ecolabeling is an important part (Asche and Smith, 2018).

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