The value of responsibly farmed fish

A hedonic price study of ASC-certified whitefish

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Abstract

In recent years, several studies have identified price premiums for wild seafood certified as sustainably produced. Even though more than half of seafood for human consumption originates from aquaculture, not much attention has been given to consumer preferences for sustainability certified farmed fish, and to the implied price premiums for such products. This is the first paper to use market data to investigate the presence of price premiums in association with an ecolabel for farmed seafood, namely the label of the Aquaculture Stewardship Council (ASC). Using hedonic price analysis, we look at premiums related to the three most consumed farmed whitefish species in Germany: rainbow trout, pangasius, and tilapia. Our results show that there exist price premiums for ASC-certified whitefish on the German market, which vary by species. Moreover, the magnitudes of the price premiums for ASC-certified products vary by retailer and brand and are negatively correlated with their price level.

Keywords: Aquaculture Stewardship Council ASC, Consumer preferences, Ecolabeling, hedonic pricing, price premium, scanner data

JEL classification: Q11, Q22

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Introduction

Large-scale aquaculture, the fastest growing food sector globally, has become a dominant source of seafood for human consumption, surpassing capture fisheries every year since 2014 (FAO, 2020). Initially, it was regarded as a production technology that could contribute to meeting the demand for seafood and, as a result, reduce pressure on wild stocks. As aquaculture production expanded, offering new ways of utilizing aquatic environments, it also gave rise to concerns about the environmental sustainability of this production process (Belton et al., 2020). The most cited issues are local pollution, environmental degradation, and impacts on wild fish stocks due to increased demand for marine ingredients in aquafeed. For wild fish stocks, the perception that existing management systems are insufficient or lacking in a number of countries has motivated private organizations to partner with retailers and consumers in an effort to improve management through ecolabeling (Roheim et al., 2018).

Ecolabels have established themselves in the seafood market as a tool to differentiate sustainably produced foods (Roheim et al., 2018; Cojocaru et al., 2021). In recent years, the use of certification schemes for farmed seafood species has become more prevalent (Osmundsen et al., 2020) and Alfnes et al. (2018) identify forty-eight different labels for aquaculture products. Despite this increase in availability, no studies have investigated the existence of price premiums for ecolabeled aquaculture products so far. In this paper, we explore pricing mechanisms for the three most consumed farmed whitefish species on the German market, using a hedonic price function applied on a unique scanner panel dataset.

Ecolabels provide information on a product's environmental performance, thereby increasing demand from environmentally conscious consumers (Sammer and Wüstenhagen, 2006). An unlabeled product does not have the same guarantee, presumably because the production process is not sustainable. Roheim et al. (2018) indicate that with increased market share of ecolabeled products, the demand for unlabeled products is expected to decline. When there are

consumer groups that demand sustainable products, a segmented market provides producers with incentives to offer products with this attribute given that the cost is not too high (Roe and Sheldon, 2007).[1] For aquaculture producers this market segmentation becomes a larger concern when they do not have access to ecolabels as in most species groups there is a high degree of substitution between wild and farmed fish (Bronnmann et al., 2016; Bronnmann, 2016; Anderson et al., 2018), with at least some wild fish harvest being certified. For capture fisheries, the leading ecolabel is offered by the Marine Stewardship Council (MSC) and was introduced in 1997 (Roheim et al., 2018). The equivalent to the MSC label for farmed seafood, the Aquaculture Stewardship Council (ASC) label, was implemented in 2012 (Bronnmann and Asche, 2017). After an ecolabel is created, it also takes time for the necessary market data to become available and make the analysis of price premiums possible. For example, for capture fisheries, Roheim et al. (2011) provided the first findings of actual premiums for MSC-labeled fish, nearly a decade after MSC-labeled products appeared on the market in 2002.[2]

A significant body of literature uses survey data to show that wild fish is preferred to farmed fish (Roheim et al., 2012; Uchida et al., 2014; Garlock et al., 2020b). These studies also show that there is a premium for ecolabeled seafood in general, but do not distinguish the effect between farmed and wild. Bronnmann and Asche (2017) use separate ecolabels for farmed and wild fish and find that the preference for wild fish largely is a sustainability concern. In their study, the premium associated with ASC-labeled salmon is so high that consumers' willingness-to-pay is equivalent to that for MSC-labeled wild salmon. This points to a consumer preference for certified farmed products over unlabeled wild fish. A number of studies using market data

[1] We do not have access to the certification costs, but Roheim et al. (2018) indicate that this varies significantly from fishery to fishery. Additionally, there can be significant costs associated with adapting to the requirements of a label. Amundsen and Osmundsen (2020) show that is the case in aquaculture.

[2] Since ecolabels for farmed seafood became available much later than for seafood from capture fisheries, some aquaculture producers have used other labelling techniques to try to mitigate the potential competition effects from ecolabeled wild seafood. Organic production and its associated label are one common approach to achieve this differentiation (Cojocaru et al., 2021), but this also entails several other changes to the production practices, such as changes in feed formulations that directly impact production cost. There is evidence of premiums associated with organic salmon (Asche et al., 2015; Ankamah-Yeboah et al., 2016)

provide evidence of price premiums associated with MSC-certified seafood, although the premiums vary by market and species (Roheim et al., 2018). Germany is one of the largest seafood markets in Europe, and is a region where ecolabels are extensively used (Asche and Bronnmann, 2017). Whitefish, of both wild and farmed origin, is the largest segment of the German seafood market (Bronnmann, 2016; Bronnmann et al., 2016), and several studies have reported price premiums for certified wild whitefish species (Bronnmann and Asche, 2016; Asche and Bronnmann, 2017; Roheim and Zhang, 2018).[3]

To investigate the market impact of the ASC label, we estimate hedonic price functions for the three most consumed farmed whitefish species in Germany: pangasius, tilapia, and rainbow trout. Hedonic price functions are commonly used to assess the value of various product attributes. For example, McConnell and Strand (2000) empirically estimate the effects of product characteristics on tuna prices in Hawaii. Given the growing interest in branding and certification schemes, this approach is increasingly employed to study the existence of price premiums associated with labels and brands for food products. Parcell and Schroeder (2007) look at factors that contribute to beef and pork product differentials with particular focus on brand premiums. Chang et al. (2010) confirm price premiums for organic eggs, while Schulz et al. (2012) find premiums for a number of beef product characteristics, including certification. For seafood, studies have employed hedonic price functions to look at price premiums that consumers pay for brands and labels (Roheim et al., 2011; Sogn-Grundvåg et al., 2014; Asche et al., 2015b; Ankamah-Yeboah et al., 2016; Bronnmann and Asche, 2016; Asche and Bronnmann, 2017).

[3] Generally, the most important whitefish species by value are wild-caught fish such as Alaska pollock and cod. In recent decades however, farmed whitefish species have increased market share (Bronnmann et al., 2016) and now make up a significant share of the global whitefish production (Asche et al. (2009).

The remainder of the paper is organized as follows. We first give some background information regarding the ASC certification and the data used in the study. The empirical analysis based on the estimation of hedonic price functions is then described, followed by a presentation and discussion of the empirical results. Finally, conclusions are drawn in the last section.

Background and Data

The first ASC farm became certified in 2012 in Indonesia and was for tilapia production. Since then, the number of certified farms and products carrying the ASC label has been rapidly growing. In addition to environmental sustainability, the ASC label also sets standards for best aquaculture practices, which include food safety, community, and animal welfare (ASC, 2020a). The main goal of the ASC program is to direct aquaculture towards environmental sustainability and social responsibility using market mechanisms that create value across the chain.

Whitefish is the most consumed group of fish in Germany, with fillets constituting the most important product form. As domestic production is very limited, virtually all whitefish products are imported. Trout comes in primarily from other European Union (EU) countries, whereas pangasius and tilapia are predominantly imported from Viet Nam and China, respectively (Destatis, 2021). It is important to note that there are essentially no wild landings of any of these species globally, and consequently, there is no trade-off between wild and farmed for the species themselves, although they compete with wild species in the larger whitefish market (Bronnmann et al., 2016).

Table 1 offers an overview of the number of ASC-labeled products globally as well as in Germany and breaks down counts by each of the three whitefish species considered in this

study. A significant increase in the number of certified ASC-labeled products over time can be observed globally, as well as for the species consumed in Germany (ASC, 2020b).

Table 1: Count of ASC-certified Unique Products per Species Globally and in Germany, for 2012, 2016 and 2019.

	Globally				Germany		
	All species	Pangasius	Tilapia	Trout	Pangasius	Tilapia	Trout
2012	158	105	53	0	21	9	0
2016	5822	1092	171	207	128	25	55
2019	20195	2579	445	729	316	101	202

Source: Aquaculture Stewardship Council (ASC, 2020b)

The data used in this study are part of the Homescan panel on food purchases of German households, collected by the Gesellschaft für Konsumforschung (GfK). The dataset is stratified to be representative of the German population. Households scanned their daily food purchases using 'European Article Number' (EAN) codes, which makes it possible to identify each purchased product. The panelists also provided information about the point and date of purchase, several product characteristics, and whether there was a promotional sale on that product.

In this study, we look at price premiums and discounts for fillets of pangasius, tilapia, and trout, with focus on the ASC label. As such, the pangasius, tilapia and trout purchases were extracted from the larger dataset. A similar approach was used by Asche and Bronnmann (2017) when investigating MSC premiums for the three most consumed wild species in Germany, namely cod, saithe and Alaska pollock. The data used span a period of 60 months, from January 2012 to December 2016. Information provided by the ASC logo license manager and EAN codes made it possible to identify all products in the data that at some point during the study period

carried an ASC label. Additionally, for each product in the dataset we were able to identify exactly when the ASC logo became active or was removed. In consequence to the usual product line deletions and additions throughout the study period, the dataset becomes an unbalanced panel.

The dataset contains 70 098 observations for 431 different EAN codes – pangasius (132), tilapia (33), and trout (266) – with 73 products (47 pangasius, 10 tilapia, 16 trout) carrying the ASC label.[4] The products were bought by 10 538 different households, having made on average 16 purchases of pangasius, tilapia, or trout products in the period under study.[5] There are different product forms, which have been categorized into fresh, frozen, smoked, and canned fillets. Among these different forms, smoked fillets have the highest purchase frequency (80%) and are mostly associated with trout products (99%). The average purchase frequency of frozen products is around 18%, followed by fresh, and canned.

The analysis includes 23 brands, each with a purchase frequency of at least 0.5%, representing approximately 95% of the dataset. The remaining brands are aggregated to the category "other". There is a clear distinction between retail brands (i.e., private label products), and traditional producer brands.[6] The former set includes eight private labels by Aldi, Lidl, Netto, Edeka, Norma, Rewe, Metro, and Penny. There are fourteen traditional national brands, such as Krone and Ternaeben, while the home delivery service, Bofrost, is included as an own brand. Overall, the purchase frequency of private label products is 67% in the dataset. Such a high share of private label products is common in German retailing, where their popularity among consumers has remained high over the years (Nielsen, 2017). Notably, not all brands carry products with the ASC label and not all product characteristics are the same for all species.

[4] A more detailed description can be found in Table A2 in the Appendix.
[5] Number of households that purchased pangasius, trout and tilapia fillets per year: 4 954 in 2012; 4 800 in 2013; 4 739 in 2014; 4 539 in 2015; 4 287 in 2016.
[6] Private label products encompass all products sold under a retailer's own brand.

Table 2 reports the descriptive statistics of the product attributes included in the analysis. Following Bronnmann and Asche (2016), the statistics are calculated with the average price in Euros (€) per 100 grams (g). Trout has the highest purchase frequency of the three species, while tilapia's purchase frequency is lowest, at under 2%. The price for tilapia is on average €1.21/100g, closest to trout, and nearly twice as expensive as pangasius (€0.63/100g). This, together with the low purchase frequency, suggests that tilapia may be a niche species, as has also been indicated by Bronnmann (2016) and Bronnmann et al. (2016).

Table 2: Descriptive Statistics

		Price of the Product Attribute in € per 100 g			
Product Attribute	**Purchase Frequency in %**	**Mean**	**Min**	**Max**	**Std. Dev.**
Species					
Trout[a]	88.19	1.38	0.39	4.79	0.47
Pangasius	10.47	0.63	0.23	2.66	0.33
Tilapia	1.36	1.21	0.40	2.92	0.57
Product Form					
Smoked	80.24	1.44	0.40	4.79	0.42
Frozen	17.70	0.68	0.23	2.99	0.42
Fresh	1.56	0.99	0.41	1.60	0.19
Canned	0.51	0.99	0.40	2.31	0.36
Brand					
Aldi[a]	34.04	1.36	0.40	2.29	0.43
Lidl	17.71	1.31	0.48	2.49	0.40
Krone	11.18	1.29	0.39	2.89	0.34
Other	4.36	1.03	0.23	4.14	0.62
Ternaeben	4.13	1.19	0.47	2.14	0.25
Penny	3.57	1.46	0.48	2.29	0.43
Netto	3.42	0.68	0.31	1.43	0.27
Norma	3.31	1.15	0.36	2.50	0.41
Laschinger	2.49	1.86	0.59	2.53	0.29
Metro	2.39	1.19	0.30	2.49	0.46
Edeka	2.30	0.66	0.44	2.50	0.23
Suempol	2.27	1.63	0.48	3.29	0.45
Friedrichs	1.70	2.19	0.55	4.79	0.73
Femeg	1.55	0.66	0.40	1.60	0.20
Danforel	1.10	1.38	0.63	3.59	0.41
Bofrost	1.10	2.00	1.33	2.99	0.46
Norfisk	0.94	1.76	0.67	2.29	0.43

Ruegen	0.77	1.40	0.47	2.26	0.47
Escal	0.75	0.54	0.40	0.66	0.09
Lenk	0.72	0.72	0.32	1.25	0.23
Guba Trade	0.58	1.03	0.41	1.38	0.20
Wechsler	0.56	2.53	0.79	4.79	0.72
Dksh	0.53	0.47	0.40	0.55	0.05
Rewe	0.52	1.57	0.60	3.39	1.13
Package Size					
<= 300 g[a]	82.16	1.44	0.33	4.79	0.43
300-500 g	9.69	0.66	0.31	2.99	0.41
> 500 g	8.15	0.70	0.23	2.16	0.40
Additional					
Regular price[a]	89.22	1.33	0.23	4.79	0.50
Promotional price	10.78	1.01	0.25	4.40	0.50
No ASC[a]	93.89	1.33	0.30	4.79	0.50
ASC	6.11	0.91	0.32	2.66	0.54
Overall Average		1.20	0.44	2.87	0.41

[a] Variables in italics indicate the base categories in the estimations

The average price for products from private labels is €1.17/100g. The lowest average price among the private label products is offered by Edeka (€0.66/100g). The purchase frequency of fillets from the home deliverer Bofrost is 1.10% and the average price is €2.00/100g for these products. The most often purchased package size is under 300g, followed by those between 300g and 500g. Products on sale are on average 0.32€ cheaper per 100g than regular-priced products. Looking at the ASC label, the average price of non-labeled products is 1.33€ per 100g, while for labeled fish it is 0.91€ per 100g. The purchase frequency of ASC-labeled products is 6.11%.

Empirical Model

The first stage hedonic price model introduced by Rosen (1974) is applied to estimate the effects of the various product attributes, such as ASC certification, brands, and other product characteristics, on pangasius, tilapia, and trout fillet pricing. This approach is commonly used when investigating seafood prices at retail level (Roheim et al., 2007; Roheim et al., 2011; Sogn-Grundvåg et al., 2014; Asche et al., 2015b; Bronnmann and Asche, 2016; Asche and

Bronnmann, 2017; Hukom et al., 2020), as well as at the ex-vessel level (Lee, 2014; Asche et al., 2015a; Blomquist et al., 2015; Gobillon et al., 2017; Pettersen and Asche, 2020). Hedonic pricing has its roots in Lancaster's (1966) theory of values, and decomposes a product's price by its attributes. The marginal price for every characteristic can be evaluated, thus describing the price deviation from a set base-product (Gobillon et al., 2017).

When different species are investigated, species are typically included as an attribute. This indicates that all other attributes are treated as common to all species (Roheim et al., 2007; Roheim et al., 2011; Sogn-Grundvåg et al., 2014; Asche et al., 2015b; Bronnmann and Asche, 2016; Asche and Bronnmann, 2017). Asche and Bronnmann (2017) are the exception in allowing the MSC-premium to vary by species. Moreover, Asche et al. (2015b) find differences between retailers and Blomquist et al. (2015) find differences by fish size, suggesting that the premiums associated with different attributes may vary by species. Hence, we follow the approach of Parcell and Schroeder (2007) and estimate a separate hedonic pricing equation for each of the three species under analysis.[7]

As the literature does not prescribe the functional form for a hedonic price function, the Box-Cox test was applied to derive the appropriate specification (Box and Cox, 1964). However, the results were inconclusive. Since the estimated values of the Box-Cox statistic exceed the critical value for all three species models, formal testing of significant differences between the level and log specifications were carried out. These show that the models are significantly different in terms of goodness-of-fit and we conclude that the log specification is the appropriate model to be used. This model specification is also consistent with other studies of seafood prices. When checking the ordinary least squares (OLS) residuals, the White test rejects the null hypothesis that the error variances are constant, signaling that heteroscedasticity must be

[7] When estimating separate equations by species, thus allowing all product attribute premiums to vary by species, we always reject the null hypothesis that the equations can be aggregated for any group of attributes with p-values <0.001.

corrected for in the standard errors (White, 1980). As a result, Eicker-Huber-White robust standard errors are computed in the model estimation.

The hedonic price model to be estimated for each of the three species can be written as:

$$\ln P_{it} = \alpha \quad + \sum_{k=2}^{K} \beta_{ki} X_{kit} \sum_{r=2}^{R} \pi_r R_{rt} + \theta ASC_{it} + \delta P_{it} + \sum_{P=2}^{P} \vartheta_p Q_{pt} + \sum_{f=2}^{F} \pi_f D_{ft} + e_{it} \quad (1)$$

where $\ln P_{it}$ denotes the natural log of the inflation-adjusted price of product *i* at time *t* measured in € per 100g, and *a* is the overall model intercept. The product attributes provided in Table 2 are included in the vector X_{Kit}. R_{rt} is a vector of dummy variables for the retailers, ASC_{it} is a binary variable referring to whether the ASC label was present, and P_{it} refers to whether the product was on sale or not.[8] We account for potential quarterly effects (Q_{pt}) and geographic region effects (D_{ft}) by including a set of dummies.[9]

In the UK, premiums for MSC-labeled fish were found to be highest for discount retailers, while no premium was identified for ecolabeled fish sold at high-end retailers (e.g., Marks & Spencer, Waitrose) (Asche et al., 2015). Moreover, different chains have been shown to employ diverse strategies with respect to how ecolabels are used (Sogn-Grundvåg et al., 2019; Asche et al., 2021). To account for this, we also estimate the model with interaction terms between retailer and the ASC label. The specification is given as:

$$\ln P_{it} = a + \sum_{k=2}^{K} \beta_{ki} X_{kit} \sum_{r=2}^{R} \pi_r R_{rt} + \theta ASC_{it} + \delta P_{it} + \sum_{k=2}^{K} d_k R_{kt} * ASC_t + \sum_{P=2}^{P} \vartheta_p Q_{pt} + \sum_{f=2}^{F} \pi_f D_{ft} + e_{it} \quad (2)$$

[8] Parcell and Schroeder (2007) also include promotional prices in their regressions when looking at variation in retail purchase prices for beef and pork products. Similarly, Roheim et al. (2007) do so for seafood. The promotion variable is not central to our study but can cause an omitted variable bias if excluded. As such, to perform a robustness check, we also carried out the analysis without the promotion variable. We identified only small numerical and no qualitative differences in the estimated coefficients, suggesting that if there are any endogeneity concerns, they only influence the promotion parameter.

[9] We define sixteen regions, one for each of Germany's federal states.

Empirical Results

Table 3 reports the estimated coefficients and implicit price premiums for each of the whitefish species under study. The price premium for each attribute is computed using the approach of Halvorsen and Palmquist (1980), as $(e^c - 1) * 100$, where c is the estimated regression parameter. In all estimated models, the base product is a frozen fillet sold at the discounter Aldi in Baden-Wuerttemberg. The base product is not ASC-labeled, carries the retailer's own private label, is not sold at a promotional price, and comes in a package under 300 grams.

Table 3: Parameter Estimations and Price Premiums

	Pangasius Coefficients	Price Effect (in %)	Tilapia Coefficients	Price Effect (in %)	Trout Coefficients	Price Effect (in %)
Product Form	*Base: Frozen*					
Smoked			0.417***	51.78	0.157***	17.06
			(0.102)		(0.009)	
Fresh	0.006	0.60			0.285***	33.02
	(0.051)				(0.027)	
Canned	0.092**	9.63	0.436**	54.71		
	(0.041)		(0.180)			
Brand	*Base: Aldi*					
Bofrost	1.320***	274.39	0.931***	153.77	1.304***	268.46
	(0.031)		(0.075)		(0.021)	
Danforel	-		-		-0.039	-3.85
					(0.043)	
Dksh	0.145***	15.6	-		-	
	(0.029)					
Edeka	0.005	0.45	-		-0.057***	-5.52
	(0.006)				(0.015)	
Escal	-		-		-0.108***	-10.23
					(0.014)	
Femeg	0.229***	25.8	-		0.029	2.93
	(0.031)				(0.017)	
Friedrichs	-		-		0.599***	82
					(0.048)	
Guba Trade	0.350***	41.96	-		-0.108***	-10.22
	(0.055)				(0.029)	
Krone	-		0.045		-0.003	-0.32
			(0.044)		(0.014)	
Laschinger	-		-		0.362***	43.57
					(0.026)	

Lenk	0.207***	22.96	0.206**	22.91	-	
	(0.035)		(0.085)			
Lidl	0.145***	15.66	-		0.067***	6.94
	(0.029)				(0.011)	
Metro	0.187***	20.6	0.123	13.1	-0.065***	-6.31
	(0.028)		(0.113)		(0.010)	
Netto	0.028	2.88	0.218**	24.3	-0.086***	-8.26
	(0.022)		(0.089)		(0.028)	
Norfisk	-		-		0.406***	50.06
					(0.031)	
Norma	-0.173***	15.89	0.223**	24.99	0.017	1.69
	(0.010)		(0.082)		(0.019)	
Penny	0.082***	8.5	-0.072	-6.91	0.142***	15.3
	(0.008)		(0.080)		(0.011)	
Rewe	0.244***	27.61	-0.045	-4.43	0.740***	109.69
	(0.012)		(0.080)		(0.019)	
Ruegen	0.058	5.92	-		0.122**	12.99
	(0.069)				(0.044)	
Suempol	-		-		0.239***	26.98
					(0.049)	
Ternaeben	-		-		-0.086***	-8.25
					(0.022)	
Wechsler	-		-		0.650***	91.58
					(0.019)	
Other	0.231***	25.94	0.798***	122.2	0.115**	12.23
	(0.031)		(0.129)		(0.040)	
Package Size	*Base: <=300g*					
>500g	-0.613***	-45.81	0.083	8.63	-0.720***	51.33
	(0.037)		(0.083)		(0.009)	
300-500g	-0.470***	-37.49	0.168*	18.24	-0.564***	-43.12
	(0.034)		(0.080)		(0.032)	
Additional						
ASC	0.058***	5.94	0.058**	5.94	0.086***	9.03
	(0.014)		(0.021)		(0.011)	
Promotion	-0.179***	-16.43	-0.204***	-18.45	-0.307***	-26.47
	(0.013)		(0.032)		(0.007)	
Quarterly Effects	*Base: Q4*					
Q1	-0.017**	-1.71	0.013	1.32	-0.031***	-3.09
	(0.007)		(0.015)		(0.003)	
Q2	-0.015	-1.48	-0.014	-1.34	-0.045***	-4.42
	(0.009)		(0.018)		(0.002)	
Q3	0.010	1.04	-0.010	-1.02	-0.044***	-4.32
	(0.006)		(0.017)		(0.003)	
Constant	-0.239***		-0.417***		0.221***	
	(0.027)		(0.128)		(0.013)	

Observations	7,337	945	61,816
Region FE	16	16	16
R^2	0.747	0.858	0.619

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The R^2 indicates that between 62% and 89% of the price variation can be explained by the respective hedonic price functions given in equation (1). The maximum variance inflation factors show that multicollinearity is not of concern. Most of the calculated parameters are statistically significant for each of the models. Moreover, *F*-tests indicate that all groups of attributes are statistically significant for all three models, as reported in Table A1 in the Appendix. Hence, all groups of product attributes influence the price of the farmed whitefish fillets considered.

As expected, the calculated price premiums show that for all species there is a premium for smoked, fresh, and canned products relative to frozen products. In the case of tilapia, the price premium of smoked and canned products is higher than 50%. Canned pangasius products fetch a price significantly higher relative to frozen pangasius. Fresh trout products generate significant premiums of 33%, while smoked trout products fetch 17% more than frozen trout.

Most of the brand dummies are statistically significant. The results indicate significant premiums which vary by brand. In line with findings from other studies, smaller package sizes generate price premiums in retailing (Roheim et al., 2007; Bronnmann and Asche, 2016; Asche and Bronnmann, 2017; Hoffmann and Bronnmann, 2019). Finally, when a product is part of a promotion campaign, the price is usually lower.

The main focus of our analysis is on the coefficients associated with the ASC label. On average, both pangasius and tilapia products sold with the ASC label fetch a price premium of 6% when compared to unlabeled products, while trout fetches a somewhat higher premium of 9%. Thus, similar to the findings of Asche and Bronnmann (2017) for the MSC label, the premiums for

ASC-certified fish vary by species. Asche and Bronnmann (2017) report an average premium of 7.47%, but when disentangling the premium by species it is highest for cod (30.6%) and close to zero and statistically insignificant for saithe and Alaska pollock. Hence, the variation in premiums for farmed species appears to be lower than for wild species. It is also somewhat lower than the 10-13% reported for a variety of MSC-labeled species in the UK (Sogn-Grundvåg et al., 2014; Asche et al., 2015b).

The results from the models with interaction terms between ASC and retailers and brands are reported in Table A3 in the Appendix. The estimated coefficients that are not influenced by the interaction terms do not change considerably, indicating that the model is stable in the other attribute dimensions. The null hypothesis that the premium associated with the ASC label is equal for all retailers and brands is rejected with a *p*-value lower than 0.001. This suggests that the retailers and brands follow different strategies when it comes to pricing ASC-labeled products. Moreover, for several retailers and brands the premium is zero or very close to zero, as also reported for the MSC-label at high-end retailers in the UK (Asche et al., (2015b).

To investigate whether there is a systematic relationship between the retailer's price level and pricing strategy for ASC-labeled products, we computed the correlation coefficient between the average price level for each of the three species in question, by retailer or brand, and the ASC premium. This correlation coefficient was found to be -0.536 for trout, -0.094 for pangasius, and -0.039 for tilapia. The negative correlation between price level and ASC premium indicates that the premium tends to decrease as the price level of the retailer or brand increases.

Concluding Remarks

In recent years, a substantial literature has provided evidence of consumer preferences for sustainably harvested wild fish signaled with ecolabels (Roheim et al., 2018). However, studies investigating price effects for farmed seafood remain scarce despite the important role such

species play in many markets. Using a panel dataset on daily food purchases for Germany, this paper provides a first analysis of actual price premiums associated with ecolabeled farmed seafood products. The study focuses on ASC-certified products for the three most popular whitefish species in Germany, namely pangasius, tilapia, and rainbow trout. It is of interest to note that all are farmed freshwater species, and while rainbow trout is primarily produced in Europe (Guillen et al., 2019), pangasius and tilapia are imported respectively from Viet Nam and China (Garlock et al., 2020a; Destatis, 2021). Moreover, none of the three species are commercially fished.

Overall, our results suggest that the ASC label generates a statistically significant price premium. However, this premium varies by species, as it is almost 9% for rainbow trout, and 5.94% for both pangasius and tilapia. These findings mirror those of Asche and Bronnmann (2017) for wild fish, in that the price premiums for labeled whitefish varies between species. Also, in common with Asche and Bronnmann (2017), the highest price premium is for the species normally considered to be of highest quality. Whether the lower premiums for pangasius and tilapia are substantiated by the fact that these species are relatively recent additions to the market and are produced outside Europe remains an open question. Moreover, the price premiums associated with the ASC label vary with retailers and brands, suggesting different pricing strategies. It is interesting to note that the negative correlation between the retailer's price level and ecolabel premium, as was reported by Asche et al. (2015b) for the MSC-label in the UK, seems to also be present here. This is important as it suggests that sustainability is treated as a quality attribute and is to a large extent expected from higher-end retailers.

The variation in premiums by species and retailers are highly important. Bush et al. (2013) indicate that certification has the potential to be an important tool for more sustainable aquaculture production. The existence of a significant price premium shows that this is at least partly true. However, it gives reason for concern that the premiums, and therefore incentives,

are weaker for the species imported from afar and with which consumers may be less familiar. This makes the increased globalization of seafood markets and rapidly growing aquaculture production (Anderson et al., 2018) a potentially bigger sustainability challenge.[10] Roheim et al. (2018) suggest that in some countries a sustainability label is a requirement for market access. That the premium is zero for several brands and retailers and that higher-end retailers generally charge higher premiums suggest that this type of segmentation is already taking place within countries, between different groups of consumers.

[10] In 2019, the fish supply on the German market was up to 89% from imports and two of the top five fish species consumed originated from aquaculture production FIZ (2019). In the U.S., the world's largest seafood importer, four of the five most consumed species are primarily farmed and imported (Shamshak et al. 2019; Love et al. (2020).

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454

Appendix

Table A1: Significance of Attribute Category Groups

Null Hypothesis	Test Statistic	Distribution	Prob > F
pangasius			
No effect of process form	5.79	F (2,15)	0.014
No effect of package size	151.3	F (2,15)	0.000
No effect of brand	0.001	F (14,15)	0.000
No effect of ASC	16.48	F (1,15)	0.001
No effect of promotional price	204.36	F (1,15)	0.000
tilapia			
No effect of process form	36.91	F (2,15)	0.000
No effect of package size	7.55	F (2,15)	0.005
No effect of brand	1535.1	F (9,15)	0.000
No effect of ASC	7.56	F (1,15)	0.002
No effect of promotional price	40.68	F (1,15)	0.000
trout			
No effect of process form	265.84	F (2,15)	0.000
No effect of package size	3973.62	F (2,15)	0.000
No effect of brand	4293.77	F (15,15)	0.000
No effect of ASC	63.21	F (1,15)	0.000
No effect of promotional price	1962.65	F (1,15)	0.000

Table A2: Number of Unique Products/ EAN Codes of the Main Brands Carrying the ASC Logo, 2012-2016

Top 24	**Trout**		**Pangasius**		**Tilapia**		**Total**	
Brands	no ASC	ASC	no ASC	ASC	no ASC	ASC	no ASC	ASC
Aldi	21	1	9	1	5	0	34	2
Bofrost	2	0	3	2	2	3	7	5
Danforel	7	3	0	0	0	0	7	3
DKSH	0	0	3	1	0	0	3	1
Edeka	8	2	3	4	0	0	11	6
Escal	3	0	0	0	0	0	3	0
Femeg	7	0	4	3	0	0	11	3
Friedrichs	10	1	0	0	0	0	10	1
Guba Trade	8	3	1	4	0	0	8	7
Wechsler	7	0	0	0	0	0	7	0
Krone	22	2	1	1	1	2	23	4

Laschinger	6	0	0	0	0	0	6	0
Lenk	0	0	2	6	0	2	2	8
Lidl	19	2	3	3	0	0	22	5
Metro	11	0	5	5	2	1	18	6
Netto	18	0	7	2	1	0	26	2
Norfisk	2	0	0	0	0	0	2	0
Norma	15	0	6	0	1	0	22	0
Other	65	2	47	13	12	1	124	16
Penny	4	0	0	1	2	0	6	1
Rewe	2	0	0	1	2	1	4	2
Ruegen	5	0	7	0	0	0	12	0
Suempol	7	0	0	0	0	0	7	0
Ternaeben	10	0	0	0	0	0	10	0
Total	258	16	100	47	28	10	385	72

Note: We have 431 different products in the dataset. 385 products never carried an ASC label, and 72 carry an ecolabel within the studied period. The difference in number of products, from 457 to 431, is that for some products the ASC label was withdrawn during the observation period.

Table A3: Estimation Results with Brand Interactions

	Pangasius Coefficients	**Price Effect (in %)**	Tilapia Coefficients	**Price Effect (in%)**	Trout Coefficients	**Price Effect (in %)**
Product Form	*Base: frozen*					
Smoked			0.419***	**52.07**	0.156***	**16.83**
			(0.103)		(0.010)	
Fresh	0.021	**2.13**			0.297***	**34.63**
	(0.051)				(0.026)	
Canned	0.090*	**9.44**	0.306	**35.83**		
	(0.042)		(0.211)			
Brand	*Base: Aldi*					
Bofrost	1.335***	**280.13**	0.971***	**163.98**	1.301***	**-0.02**
	(0.040)		(0.078)		(0.021)	
Danforel	-		-		-0.000	**2.55**
					(0.048)	
Dksh	0.130**	**13.84**	-		-	
	(0.044)					
Edeka	0.022***	**2.19**	-		-0.048***	**-6.34**
	(0.005)				(0.015)	
Escal	-		-		-0.111***	**12.9**
					(0.014)	
Femeg	0.161***	**17.49**	-		0.025	**82.05**
	(0.046)				(0.017)	
Friedrichs	-		-		0.599***	**26.81**

					(0.047)	
Guba Trade	0.111	**11.77**	-		-0.121***	**-11.4**
	(0.103)				(0.026)	
Krone	-		0.061	**6.25**	-0.005	**-0.5**
			(0.054)		(0.014)	
Lenk	0.097**	**10.16**	0.374**	**45.31**	-	
	(0.041)		(0.163)			
Lidl	0.101*	**10.62**	-		0.064***	**6.6**
	(0.051)				(0.011)	
Laschinger	-		-		0.361***	**1.6**
					(0.025)	
Metro	0.144***	**15.54**	0.166	**18.02**	-0.065***	**43.44**
	(0.038)		(0.114)		(0.010)	
Netto	0.014	**1.4**	0.216**	**24.12**	-0.089***	**15.15**
	(0.020)		(0.089)		(0.028)	
Norfisk	-		-		0.404***	**267.2**
					(0.031)	
Norma	-0.184***	**-16.82**	0.228**	**25.57**	0.016	**-8.54**
	(0.006)		(0.082)		(0.019)	
Penny	0.098***	**10.31**	-0.066	**-6.36**	0.141***	**-8.35**
	(0.006)		(0.079)		(0.011)	
Rewe	0.261***	**29.76**	-0.066	**-6.39**	0.740***	**109.62**
	(0.012)		(0.079)		(0.019)	
Ruegen	0.031	**3.19**	-		0.121**	**49.74**
	(0.083)				(0.044)	
Suempol	-		-		0.238***	**-4.73**
					(0.049)	
Ternaeben	-		-		-0.087***	**-8.35**
					(0.022)	
Wechsler	-		-		0.650***	**91.54**
					(0.019)	
Other	0.189***	**20.81**	0.800***	**122.62**	0.105**	**11.07**
	(0.057)		(0.129)		(0.041)	
Package Size	*Base: <300g*					
>500 g	-0.609***	**-45.63**	-0.055	**-5.36**	-0.720***	**-51.32**
	(0.036)		(0.153)		(0.009)	
300-500g	-0.486***	**-38.47**	0.036	**3.65**	-0.563***	**-43.03**
	(0.042)		(0.150)		(0.032)	
Additional						
ASC	0.029***	**2.95**	-0.106	**-10.01**	-0.248***	**-21.97**
	(0.007)		(0.124)		(0.045)	
Promotion	-0.180***	**-16.45**	-0.203***	**-18.41**	-0.307***	**-26.4**
	(0.013)		(0.032)		(0.007)	
Quarterly Effects	*Base: Q4*					
Q1	-0.020**	**-1.7**	0.009	**0.93**	-0.030***	**-2.95**
	(0.007)		(0.017)		(0.003)	
Q2	-0.016	**-1.57**	-0.017	**-1.68**	-0.044***	**-4.28**

	(0.010)		(0.019)		(0.002)	
Q3	0.008	**0.85**	-0.016	**-1.63**	-0.043***	**-4.17**
	(0.007)		(0.017)		(0.004)	
ASC Brand Interactions	*Base: ASC Aldi*					
ASC X Bofrost	-0.036***	**-0.73**	0.121	**1.59**	-	
	(0.006)		(0.120)			
ASC X Danforel	-		-		0.157**	**-8.69**
					(0.058)	
ASC X Dksh	-0.035**	**-0.57**	-		-	
	(0.013)					
ASC X Edeka	-0.016*	**1.33**	-		0.255***	**0.7**
	(0.008)				(0.049)	
ASC X Femeg	0.123***	**16.43**	-		-	
	(0.017)					
ASC X Friedrichs	-		-		-0.028	**-24.09**
					(0.072)	
ASC X Guba Trade	0.237**	**30.44**	-		0.327***	**8.18**
	(0.084)				(0.037)	
ASC X Krone	-		0.124	**1.83**	0.363***	**12.15**
			(0.166)		(0.058)	
ASC X Lenk	0.117***	**15.67**	-		-	
	(0.025)					
ASC X Lidl	0.049	**8.09**	-		0.430***	**19.95**
	(0.029)				(0.042)	
ASC X Metro	0.093***	**12.98**	-0.058	**-15.12**	-	
	(0.015)		(0.185)			
ASC X Netto	0.124	**16.57**	-		-	
	(0.097)					
ASC X Rewe	-		0.263*	**17.08**	-	
			(0.126)			
ASC X Wechsler	-		-		-	
ASC X Other	0.086	**12.16**	-		0.593***	**41.15**
	(0.069)				(0.066)	
Constant	-0.211***		-0.281		0.222***	
	(0.039)		(0.174)		(0.013)	
Observations	7,337		945		61,816	
Region FE	16		16		16	
R-squared	0.750		0.862		0.621	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

. Adapted from Harrell (2015) with the suggestions of Halvorsen and Palmquist (1980), the price effect of the ASC certification for a certain retailer follows Asche and Bronnmann (2017) and can be written as $E_{rj} = ((e^{ASC+d_j}) - 1) * 100$, where *ASC* denotes the coefficient of the ASC variable and d_j is the interaction effect.

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