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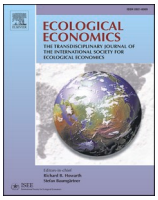

Certify or not? The effect of the MSC certification on the ex-vessel prices for Atlantic cod in Norway

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ABSTRACT

There is strong evidence that ecolabeled seafood commands a price premium in the retail market in Northern European countries. At the same time, there is significant uncertainty as to whether these markups are passed on to the fishers. This is important because producer benefits are required for an ecolabel to provide incentives for sustainable fishery management and fishing practices. Therefore, we investigate whether fishers obtained price premiums for certified cod in Norway. A unique setting for this investigation was created when a part of the fishery, the one conducted within the Norwegian territorial waters, lost its certification by the Marine Stewardship Council (MSC), while it was maintained for the offshore part of the fishery. Using a difference-in-difference approach, analyzing a large and detailed dataset, we find that on average, there is no premium for certified cod, and that other factors are more important. When controlling for buyer types, the loss of the MSC certification resulted in a price reduction for cod sold to producers who make fillets for Northern European markets. However, we found no significant price effect for cod sold to the other buyer types. This highlights the difficulty of obtaining a price premium when there are alternative sources of the product.

1. Introduction

During the last couple of decades, voluntary initiatives that certify producers' sustainable production methods by means of an ecolabel have become increasingly popular. In theory, ecolabels enable consumers to differentiate among products based on their sustainability attributes. Fish is one group of products where the sustainability of the production process has been receiving much attention (Roheim et al., 2018). Ecolabels, with that of the Marine Stewardship Council (MSC) being the most prominent, provide consumers with assurance that certified products originate from a fishery with sustainable stock management and fishing practices. To the extent that an ecolabel differentiates otherwise homogenous products among consumers, environmentally conscious consumers may shift their demand from non-certified products to certified ones, resulting in price premiums for ecolabeled products (Gudmundsson and Wessells, 2000; Roe and Sheldon, 2007).

Consumer recognition and acceptance of ecolabeled seafood have motivated several studies using market data to investigate the price effects associated with ecolabeled seafood products at different stages at the supply chain. At the retail level, studies in Germany and the UK reported price premiums for MSC-certified seafood of up to 30% (Asche et al., 2015; Asche and Bronnmann, 2017; Sogn-Grundvåg et al., 2013, 2014), as well as premiums for other labels such as that of the Aquaculture Stewardship Council (Asche et al., 2021). An equally important part of the theory of ecolabels is that incentives are created for producers to meet the certification standards, as this is what incentivizes producers to adopt more sustainable production practices (Blackman and Rivera, 2011; Roheim et al., 2018). Because the cost of such certification is

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substantial and borne by producers, increased revenues are required for fishers to invest in certification (Goyert et al., 2010). This implies that a sufficiently high share of price premiums gained at the consumer level of the supply chain must be transmitted upstream to the fishers.[1] However, that a substantial number of fishers and fisheries have withdrawn from, or not renewed, their MSC certification indicates that this is not always the case (Pierucci et al., 2022).

Limited data availability has made the assessment of potential upstream price premiums difficult, and mixed evidence is obtained with a variety of approaches. Wakamatsu (2014) analyzed the effect of MSC certification on ex-vessel prices for flathead flounder in three Japanese fish markets using structural break tests and found no evidence of a price premium. Stemle et al. (2016) used annual data, where the potential signal is much weaker, and found indications of a positive price premium for MSC-certified chum and pink salmon and for flathead flounder but no premium for halibut and chinook, coho, and sockeye salmon. Blomquist et al. (2015) studied the Swedish Baltic cod fishery, using non-certified western Baltic cod as a control group, and found no price premium. However, it may take some time for processors, retailers, and restaurants to obtain MSC chain-of-custody certification. This may delay the supply of MSC-labeled fish, which may explain the lack of a premium (Blomquist et al., 2020). Studying the same fisheries before and after the suspension of the MSC certificate in 2015, Blomquist et al. (2020) found a price premium of 11% for small cod (0.3–1 kg) prior to the suspension, but no premium for larger cod. Fernández Sánchez et al. (2020) found price premiums between 15.2% and 24.6% for common octopus in the Spanish Asturias region sold by MSC chain-of-custody–certified vessels compared to non-certified vessels. Finally, Andersson and Hammarlund (2023) investigated MSC-certified vessels fishing for Norway lobster in Sweden and found no general effect of MSC certification on prices and quantities.

The mixed evidence with respect to upstream premiums for the MSC label has also led to alternative hypotheses to explain why a premium can exist at the retail level without having an upstream impact, such as a consumer warm glow (Bronnmann et al., 2021), lower logistic costs due to longer product life spans (Sogn-Grundvåg et al., 2019), and reduced substitutability (Roheim and Zhang, 2018). Moreover, Asche et al. (2015, 2021) show that low-end retailers charge a higher premium for MSC-certified products than high-end retailers, and some high-end retailers do not charge a premium because sustainably produced food is part of the services they offer to their customers.

This study investigates price premiums for Atlantic cod in Norway, a much larger fishery than the ones discussed above. In 2020, the global catch of Atlantic cod was nearly 1.1 million tons, from which the Norwegian share was 30% (FAO, 2022). A unique situation occurred in 2021 as the MSC certificate for cod caught within the national territorial waters was suspended due to the poor state of the stationary coastal cod stock. In contrast, the MSC certification for cod caught outside of the territorial waters was still valid as this cod belongs to the healthy Barents Sea stock. In 2020, about 50% of the cod landed by Norwegian vessels was caught outside of the territorial waters. As the fishery for cod operates both outside and within the territorial waters, both certified and non-certified cod are landed, creating an ideal setting for investigating price premiums at the ex-vessel level of the supply chain. More specifically, we conduct econometric analysis on a detailed dataset consisting of 1,474,729 ex-vessel transactions of Atlantic cod using a difference-in-difference (DID) approach.

The setting is highly interesting, as it provides a microcosm of the larger seafood market. While there are global markets for most species with common pricing processes, the seafood market is also highly heterogenous, with many species and markets resulting in different margins (Anderson et al., 2018). There are also many buyers and sellers for each species, and in each market (Straume et al., 2020; Oglend et al., 2022), and as shown by Asche et al. (2015, 2021), ecolabels may have different values to different buyers. If one group of fishers loses the MSC certification, one would expect that they will try to shift their supply to other markets which do not require MSC certification. Given that MSC certification is of greater significance in Northern Europe and North America (Roheim et al., 2018), there are other potential markets for cod available. If the demand for MSC-certified cod can be met by the certified portion of the fishery or by other certified suppliers, such as Icelandic cod fisheries, it may not be apparent that there will be a substantial MSC premium. Our detailed dataset provides information about the production profiles of the buyers, with some buyers focusing on salted and dry-salted cod for markets in Southern Europe that in general do not request MSC certification, and some focusing on frozen fillets for Northern European markets.

The paper is organized as follows: In the next section, a background is provided where the Norwegian cod fishery and MSC certification are reviewed. Here, the organization of the ex-vessel market is also described. This is followed by a section describing the data and econometric models. Finally, empirical results are presented and discussed.

2. The Norwegian cod fishery and MSC certification

The Norwegian fishery for Atlantic cod is the most valuable fishery in Norway (Cojocaru et al., 2019; Pincinato et al., 2022), and with Norway's limited population, most of the fish is exported (Straume et al., 2020). In 2021, 381,732 tons of cod were landed at an ex-vessel value of NOK 7.4 billion. Cod landings between 2015 and 2021 varied between 329,897 tons in 2019 and 422,478 tons in 2015, averaging 381,685 tons. The fishing fleet taking part in the cod fishery is diverse, ranging from small and medium-sized coastal vessels fishing with demersal seines, gillnets, longlines, and handlines, delivering fresh catches to local fish plants daily, to large oceangoing bottom trawlers and long-liners freezing their catches at sea to allow longer trips. In addition, large coastal vessels fishing with gillnets or demersal seines deliver fresh cod, and some of these also freeze some of their catches.

The cod fishery is regulated on a single-species basis with an annual total allowable catch (TAC) for the main species. Since 2001, the International Council for the Exploration of the Sea has provided separate management advice for the migratory Northeast Arctic (NEA) cod and the stationary Norwegian coastal cod (NCC) north of 62°N (Dahle et al., 2018). But only one TAC for Atlantic cod is set. The management system divides the large and diverse fishing fleet into several different vessel groups based on gear type, target species, and vessel sizes. The TAC for cod and other key species is distributed among the different vessel groups and within each group in individual vessel quotas.

Due to their large sizes, the oceangoing bottom trawlers and long-liners can catch fish in the high seas year-round. In 2021, the trawler group consisted of 37 vessels which are prohibited from fishing within the Norwegian territorial waters 12 nautical miles (22,224 m) off the coast.[2] The group of oceangoing long-liners consisted of 21 vessels in 2021. These fish with 50,000–70,000 mechanically baited hooks (Sogn-Grundvåg et al., 2020) and are not allowed to fish within 4 nautical miles off the Norwegian coast.

A key characteristic of the coastal cod fishery is a strong seasonal profile reflecting the yearly spawning migration of NEA cod from its feeding grounds in the Barents Sea to the coast of Northern Norway. This makes the NEA cod catchable for the coastal fleet, and on average, 75% of the fresh cod landed in Northern Norway is landed during the main spawning months of February, March, and April (Hermansen and Dreyer, 2010; Birkenbach et al., 2022). Coastal vessels fishing with

[1] Alternatively, fishers' revenues can be increased by improved market access and sales. This entails a price premium when the market the ecolabel gives access to pays a higher price.

[2] Some bottom trawlers have licenses allowing them to fish between 6 and 12 nm off the coast provided that the catch is processed.

gillnets and demersal seines land approximately 80% of the fresh landings from the coastal fleet (Sogn-Grundvåg and Hermansen, 2022). This gear choice reflects reduced harvesting costs when catchability is high (Bertheussen and Dreyer, 2019; Sogn-Grundvåg et al., 2022).

The Norwegian part of the cod fishery in the Barents Sea (north of 62°N) was MSC certified on April 26, 2010,[3] after a 17-month assessment period.[4] During the assessment, it became clear that the poor stock situation of coastal cod was a hindrance to certification.[5] As a result, certification was done in two steps, where cod fishing outside of the Norwegian territorial waters was certified in 2010 and cod fishing within the territorial waters was certified more than a year later. The latter was based on the condition that a plan for rebuilding the coastal cod would bring the stock to a certifiable level by 2015. This failed, but a new five-year certificate ending on April 26, 2021, was granted based on the same condition. A short extension was given due to a complaint by the World Wildlife Fund claiming among other things that the certificate did not acknowledge that the common redfish (*Sebastes norvegicus*) was a threatened species. When the complaint had been addressed, the MSC certificate for cod fishing within Norway's territorial waters was suspended on 15 August 2021.

Figure 1, Panel A, shows the limits of the Norwegian territorial waters north of 62°N. Fig. 1, Panel B, shows that important fishing and spawning areas for cod such as Malang bank and Sveins bank are both outside and within the territorial waters. During the spawning season, NEA cod and coastal cod may be observed at the same spawning grounds at the same time (Johansen et al., 2018), creating a significant challenge for sustainable harvesting of NEA cod while protecting the coastal cod from overfishing (Dahle et al., 2018). In this mixed-stock fishery, it is impossible to distinguish coastal cod from NEA cod based on morphological traits such as size, condition, body shape, and skin color (Dahle et al., 2018).

The ex-vessel sale of wild-caught fish in Norway is legally regulated by the Raw Fish Act and is organized by six sales organizations owned by fishers. The Norwegian Fishermen's Sales Organization (NFSO) is the largest sales organization for groundfish and covers all landings from Nordmøre in the southwest of Norway to Finnmark in the northeast. Fresh cod is landed directly to designated buyers, and prices are negotiated for each catch. For frozen cod, vessels may sell through an online auction managed by the NFSO (Sogn-Grundvåg et al., 2021). Atlantic cod is a versatile raw material that is processed into a wide variety of products depending on the plant's setup, including several types of fresh and frozen fillets and different stockfish, saltfish, and dry-salted products (Gordon et al., 1993; Mazany et al., 1996). The choice of product form produced is at least partly dependent on relative prices and market conditions (Asche and Hannesson, 2002). For frozen cod, a substantial share is exported to China, where it is mainly processed and re-exported (Asche et al., 2022a). Due to the findings of previous studies, we will not be including the potential impacts of the COVID-19 pandemic on Norwegian fisheries and seafood exports. According to Asche et al. (2022b, 2022c) and Straume et al. (2022), the pandemic had minimal effects on the industry, with only secondary-level impacts, such as slightly longer storage times and changes in market focus for larger firms. Additionally, there were no significant impacts on market prices.

3. Data and methodology

For our analyses, we used ex-vessel data for Atlantic cod landed in the northernmost regions of Norway from January 2015 to September 2022. Data was provided by the NFSO and contains detailed information on 1,454,729 transactions, such as the date of the transaction, the size categories of the cod in kg, the quality (a buyer-reported quality index), and whether the fish was caught outside or within the territorial waters. The price for each catch was calculated in NOK per kg by dividing the real value of the sales by their round weight. For the econometric analysis, prices were deflated using the Producer Price Index (PPI) from the Central Bank of Norway. We can observe that the overall trend of the PPI in Norway has been increasing since 2015, with some fluctuations. On average, the PPI increased by about 3.9% per year from 2015 to 2018, then decreased by 10.5% in 2019. From 2020 to 2021, the PPI increased by 27.5% on average (Fig. 3). Table 1 provides descriptive statistics for the variables included in the analyses. The descriptive statistics were calculated in NOK per kg.

Figure 2 displays the different areas, numbered from north to south, starting with Area 1, which covers the eastern part of Finnmark, followed by Area 2, which covers the western part of Finnmark, Area 3 covering Troms, Area 4 covering Vesterålen, Area 5 covering Lofoten, and lastly Areas 6 to 9 covering Helgeland to Nordmøre.

The average price of cod in the period under study was NOK 14.61 per kg. Most of the cod transactions (45%) were caught with gillnets, followed by jigs (26%) and lines (15%). On average cod caught by bottom trawlers were the most expensive (NOK 17.64 per kg). Regarding the size of fish, large cod achieved an average price of NOK 15.05 per kg, and the price decreased with the size category. Most of the cod (52%) was in the size category of 2.5–6 kg, followed by cod larger than 6 kg (24%). The price for cod of extra quality was NOK 19.22 per kg, while the price for cod of downgraded quality was NOK 9.62 per kg.[6]

The dataset contained 89% fresh fish landings with an average price of NOK 18.26 per kg. Moreover, 26% of the cod was landed in Area 5, followed by Area 2 (19%) and Area 3 (18%). During the different quarters of the year, the prices were similar. From 2015 to 2020, the average prices more than doubled and reached their peak in 2020 with NOK 23.18 per kg.

The dataset also contained the names of all buyers. These were categorized into four main types. Conventional fish buyers, with a 50% share of transactions, mainly produce salted and dry-salted products destined for the Southern European and South American markets. Fresh fish buyers (26%) mainly supply whole fresh fish for various supply chains, including for the Eastern European processing industry, where cheap labor is used to make fillet products for low-end retailers, as well as European fish auctions and supermarket chains. Fillet buyers (17%) mainly produce fresh and frozen fillets for Northern European supermarkets and restaurants. Traders are a small group of companies representing less than 2% of transactions, mainly trading in fresh whole fish. Other buyers (5%) are represented by very small buyers such as local fishmongers and small producers of fish food.

In this study, we take advantage of an ideal setting for investigating price premiums for sustainability certification at the producer level of the supply chain created by the suspension of the MSC certificate for cod caught within the territorial waters, while the MSC certificate is still

[3] Norway and Russia share the Barents Sea cod stock with several other nations, but Norway and Russia keep approximately 85% of the cod TAC for themselves. The Russian company Ocean Trawlers was granted MSC certification for cod on October 24, 2010 (see Hønneland, 2021, for more details on MSC certification of other nations and companies fishing for cod in the Barents Sea).

[4] The costs of the initial assessment were covered by the Norwegian Seafood Council, but the Norwegian Fishermen's Association covered the reassessment costs. Thus, in contrast to fisheries where certification costs are covered by individual vessels, such as for *Nephrops* in Sweden (Andersson and Hammarlund, 2023) and common octopus in Spain (Fernándes Sánchez et al., 2020), the certificate covers the entire Norwegian fleet.

[5] Whether stationary coastal cod and the Northeast Arctic cod represent different populations has been a controversial research topic since the 1930s (Berg et al., 2017; Johansen et al., 2018). But more recent research based on genetic studies, tagging experiments, and otolith patterns indicates that they can be treated as reproductively isolated populations (Neuenfeldt et al., 2013).

[6] The standard quality category is referred to as “A quality,” while “extra quality” indicates a higher quality level. Cod that is not fresh enough or has other imperfections is considered as “downgraded quality.”

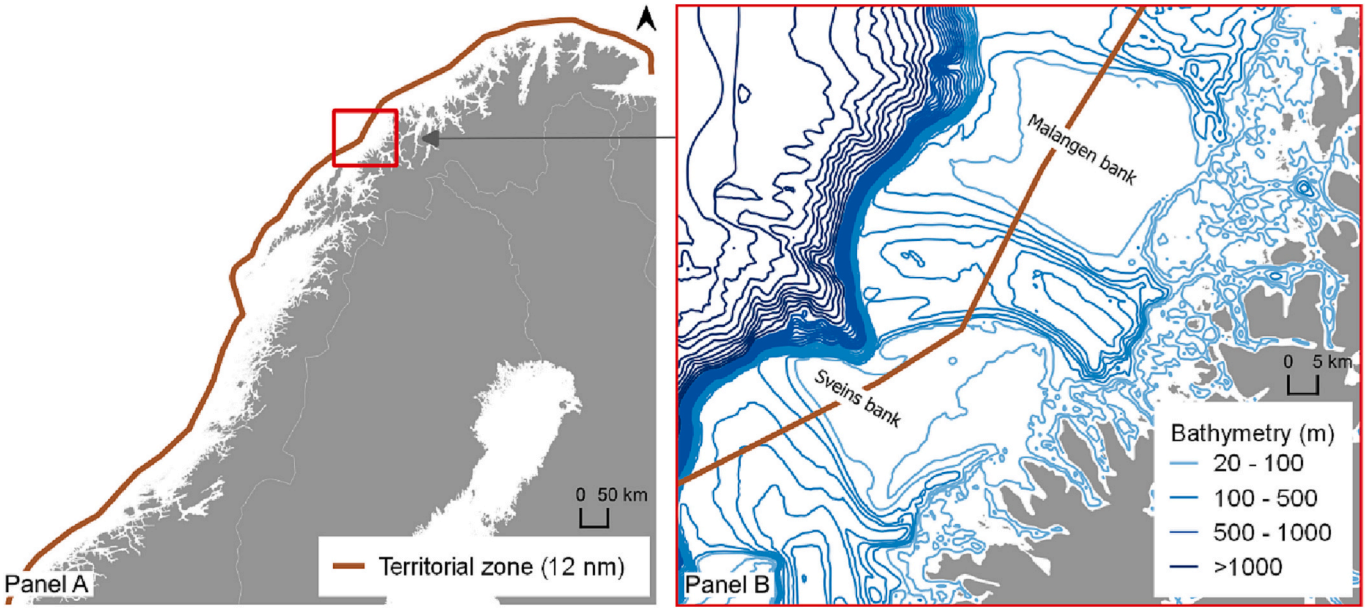

Fig. 1. Map of Northern Norway with the territorial zone (panel A) and a section showing key fishing areas (panel B). Source: The Norwegian mapping authority and Eurostat (land: Countries, 2020—Administrative Units—Dataset).

valid outside the 12-nautical mile territorial limit. For the investigation, we employed a difference-in-difference (DID) approach (Cameron and Trivedi, 2005; Imbens and Wooldridge, 2009), which allowed us to control time-varying factors and common trends in the treatment and control groups. We studied changes in the relationships of prices between cod caught within the 12 nm zone (treatment group) and cod caught outside the 12 nm zone (control group) after the fishery within the 12 nm zone lost its MSC certificate on September 15, 2021. Following the procedure of Imbens and Wooldridge (2009), also applied in Stemle et al. (2016) and Blomquist et al. (2020), among others, the general DID estimator, which indicates the average treatment effect, can be calculated as follows:

$$DID_{Loss\ of\ MSC}: \left(p_1^{outside\ 12\,nm} - p_0^{outside\ 12\,nm}\right) - \left(p_1^{within\ 12\,nm} - p_0^{within\ 12\,nm}\right), \quad (1)$$

where $p_0^{within\ 12\,nm}$and $p_1^{within\ 12\,nm}$ are the average prices of cod landings within the 12 nm zone before and after the suspension from the MSC program, respectively. If the suspension of the MSC certificate produced negative spillover effects on cod prices, we would expect DID<0.

All OLS model assumptions apply to the DID method (Lechner, 2010). In addition, the DID method requires a parallel trend assumption (Khandker et al., 2010), which implies that unobserved characteristics affecting the loss of the MSC certification do not vary over time with treatment status. To satisfy the common trends assumption necessary for a DID design, additional control covariates are important when observed heterogeneity may confound the identification strategy. To determine average unobservable counterfactuals, it is usually assumed that all differences between treated and untreated groups are reflected in a vector **X** of observable characteristics (Imbens and Wooldridge, 2009; Angrist and Pischke, 2009).

Previous studies showed that the type of fishing gear and the quality and size of fish influence ex-vessel prices (e.g., Blomquist et al., 2020; Pettersen and Asche, 2020; Sogn-Grundvåg et al., 2020; Ray et al., 2022; Wolff and Asche, 2022), which are included in the regressions. Additionally, we included different landing areas and whether the cod was frozen or fresh. Relying on model specification tests, we use the semi-log model specification and estimate our model as follows:

$$lnprice_{it} = \beta_1 within\,12\,nm_i + \beta_2 post_t + \beta_3 within\,12\,nm_i \cdot post_t + X_{it}^{'}\delta + month_t + year_t + \varepsilon_{it}, \quad (2)$$

where ln $price_{it}$ is the deflated log price of cod i at time t, $within\ 12\ nm_i$ is an indicator equal to one if the cod i was caught within the 12 nm zone (treatment group), $post_t$ is an indicator equal to one in the periods after the fisheries were suspended from the MSC certification, X'_{it} is the set of attributes previously described (see also Table 1), and $month_t$ and $year_t$ are month and year fixed effects, which control for unobservable time heterogeneity. The DID estimator, β_3, is the coefficient of the interaction between *within 12 nm* and *post,* which we define as the loss of the MSC certification or no MSC certification. ε_{it} is the random error term.

As noted above, DID relies on parallel trends in the treatment and control groups. However, parallel trends are not formally testable. The development of the monthly cod prices from January 2015 to September 2022 outside and within the 12 nm zone is shown in Fig. 3. The first dashed vertical line indicates the date of the MSC's suspension for cod caught within territorial waters. Visual inspection of the data in Fig. 3 suggests no obvious pre-trends, and there is a significant price difference within and outside the 12 nm zone, even before the MSC suspension. This is because most cod caught outside the 12 nm is frozen, while cod caught within is mainly fresh. In general, frozen cod receives a higher price than fresh cod, as most frozen cod is sold at auctions, which exposes it to more competition (Helstad et al., 2005; Sogn-Grundvåg et al., 2021), and it is storable, while fresh cod is landed by coastal vessels with less ability to transport the fish (Pettersen and Asche, 2020).

4. Empirical results

The results from the general DID estimator (Eq. 1) are shown in Table 2. Prices decreased in the period after the MSC suspension. The average price for cod caught outside the 12 nm zone, which is MSC certified (control group), was NOK 16.34 per kg in the period before the suspension and NOK 10.23 per kg in the period after the suspension, which implies a reduction of NOK 6.11 per kg. For the uncertified cod that was caught within the 12 nm zone (treatment group) after the suspension, we found a mean difference between the two periods of NOK 6.20 per kg. Hence, the DID estimator of the average cod prices was −0.10 NOK per kg and was statistically significant at the 1% level. This represents a price discount of around 10% for the uncertified cod compared to the certified cod.

Table 3 presents the results of our regression analyses (Eq. 2). We present the double different coefficients for three different models. The

Table 1
Descriptive statistics.

Variable	Frequency in %	Price of the attribute in NOK per kg			
		Mean	Min	Max	Std. Dev.
Gear					
Gillnet	45.18	14.06	3.82	95.80	4.56
Jig	25.85	14.74	3.82	86.55	4.55
Line	15.25	14.80	1.24	88.27	4.54
Demersal seine	9.75	15.73	2.34	76.10	4.94
Autoline	2.05	16.43	3.06	41.96	4.89
Bottom trawl	1.53	17.64	1.59	38.27	4.74
Other	0.38	13.87	3.52	87.35	4.40
Size					
Medium (2.5–6 kg)	51.90	14.72	3.82	95.80	4.71
Large (>6 kg)	23.72	15.05	4.11	87.35	4.37
Small (1–2.5 kg)	22.00	13.94	2.90	91.14	4.64
XS (<1 kg)	2.04	13.39	1.65	44.19	4.83
Unknown size	0.35	19.10	1.24	40.76	5.84
Quality					
A	96.71	14.78	1.24	95.80	4.56
Downgraded	3.21	9.62	1.59	91.14	4.49
Extra	0.08	19.22	10.91	47.96	3.97
Conservation method					
Fresh	89.03	14.54	1.24	95.80	4.61
Frozen	1.97	18.26	1.59	38.27	4.93
Landing area					
Area 5	26.15	15.18	1.95	86.03	4.88
Area 2	19.07	14.39	3.34	86.55	4.73
Area 3	18.01	14.52	1.59	91.14	4.66
Area 1	14.01	14.98	1.24	87.35	4.75
Area 4	12.86	14.63	3.82	46.46	4.20
Areas 6–9	9.90	13.16	3.82	95.80	3.88
Buyer Type					
Conventional buyer	50.36	14.62	1.65	86.03	4.59
Fresh fish buyer	25.58	14.41	2.34	95.80	4.59
Fillet buyer	16.89	15.05	1.24	91.14	4.52
Other buyer	5.45	14.18	1.59	64.05	5.45
Trader	1.73	14.67	2.90	37.77	5.60
Annual Quarter					
Q1	49.14	14.78	1.24	91.14	4.41
Q2	31.06	14.39	3.81	88.27	4.95
Q3	9.31	14.20	1.59	95.80	5.19
Q4	10.50	14.84	2.34	87.35	4.24
Year					
2015	15.05	10.32	2.90	87.35	2.13
2016	13.72	16.42	1.24	88.27	2.36
2017	13.43	14.70	5.73	83.42	1.84
2018	12.80	14.42	1.65	47.58	1.86
2019	10.78	17.60	6.86	91.14	2.33
2020	11.23	23.18	6.80	63.29	3.55
2021	12.70	12.21	1.95	95.80	2.40
2022	10.29	9.10	1.59	86.03	1.54
Total		14.61	1.24	95.80	4.65

Landing areas refer to geographical areas along the coast where the fish was landed.

first model does not contain any controls, the second model contains the covariates introduced above, and in the third model, the loss of the MSC certification (DID) was interacted with different buyer types. Price premiums were calculated using the approach of Halvorsen and Palmquist (1980), as $(e^{\beta} - 1) \cdot 100$, where e is the base of the natural exponential function and β is the estimated regression parameter. Standard errors were corrected for heteroscedasticity using the White estimator (1980) and clustered by conservation, fish size, quality, gear type, and buyer type. Multifactorial analysis of variance (ANOVA) demonstrated the statistical significance of each attribute category for all estimated models. Table 4 presents the significance of the main effects for Model 3. The ANOVA results including $\omega 2$ as effect size estimators for each variable are depicted in Table A1 in the appendix.

Model 1 (Table 3) shows negative price effects for cod caught within the 12 nm zone (−6.41%) and for cod caught in the period after the suspension of the MSC certificate (−36.37%). The price discount for the loss of MSC, the DID estimator, was calculated as $(e^{-0.066-0.041} - 1) \cdot 100 = -10.15\%$ and is statistically significant at the 1% level. This supports the findings from the general DID estimator, shown in Table 2.

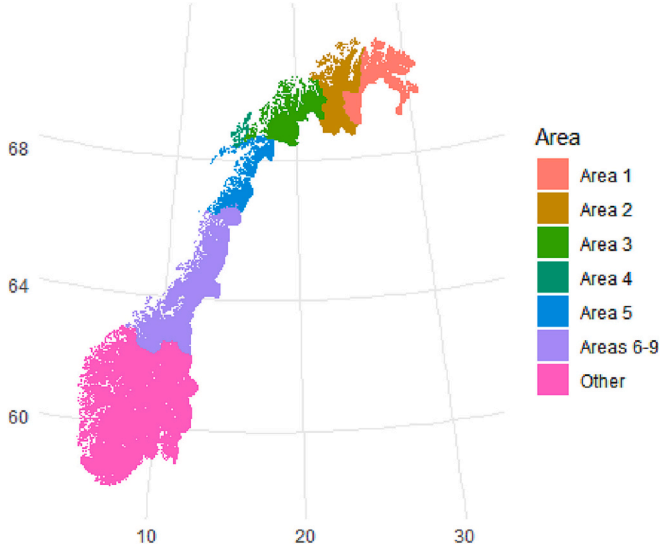

Fig. 2. Map of Norway with the landing areas in NFSO district.

When including covariates in the model, the price discount for cod caught inside the 12 nm zone decreased to −1.58%, and the price effect for cod caught after the MSC suspension is now −23.52%. The price effect for the loss of the MSC certification is now $(e^{-0.016+0.011} - 1) \cdot 100 = -0.44\%$. Moreover, a Wald test of the restriction that the sum of the coefficients "*within 12 nm*" and the "*DID*" is equal to zero could not be rejected, with a p-value of 0.632. Thus, the loss of the MSC certificate within the territorial waters does not have a statistically significant effect on cod prices.

Looking at the other variables in Model 2 (Table 3), we found that cod caught by bottom-trawling generates the highest price premium (4.12%), followed by demersal seine (3.62%) and Autoline (2.61%). Discounts are generated for smaller cod, while larger cod carries a premium, in line with Pettersen and Asche (2020). Cod of extra quality achieved price premiums of 41.81% compared to quality A, and cod landed in Area 5 is the most expensive.

Additionally, we found a significant price premium of 29.99% for frozen cod compared to fresh cod. Fishers selling to fillet buyers achieved on average the highest price premium (2.68%), followed by those selling to fresh fish buyers (1.28%) compared to conventional buyers. However, the average price premiums for fishers selling to other buyers and traders are negative. We found price discounts in Quarters 2–4 compared to the base category, Quarter 1. Price premiums are detected for all years compared to the base year, 2015, with the highest price premium in 2020 (126.47%).

In Model 3, we allowed the price effect of the loss of the MSC certification to vary by different buyer types by including interaction terms. When including buyer type interactions, the DID variable *Loss of the MSC label* is now related to conventional buyers. However, the effect is not statistically significant ($p > 0.202$). The only statistically significant effect here is for fillet buyers ($p > 0.000$), the group of buyers serving market segments where MCS certification is known to be important in some countries. Our results indicate that the loss of the MSC certification resulted in a statistically significant (p > 0.000) price reduction of −4.78% $((e^{(-0.016+0.029-0.060)} - 1) \cdot 100)$ for fishers selling to this type of buyers, as they could no longer sell this fish in the high-paying Northern European markets.

5. Discussion and conclusions

According to the theory of change of MSC, the MSC certification

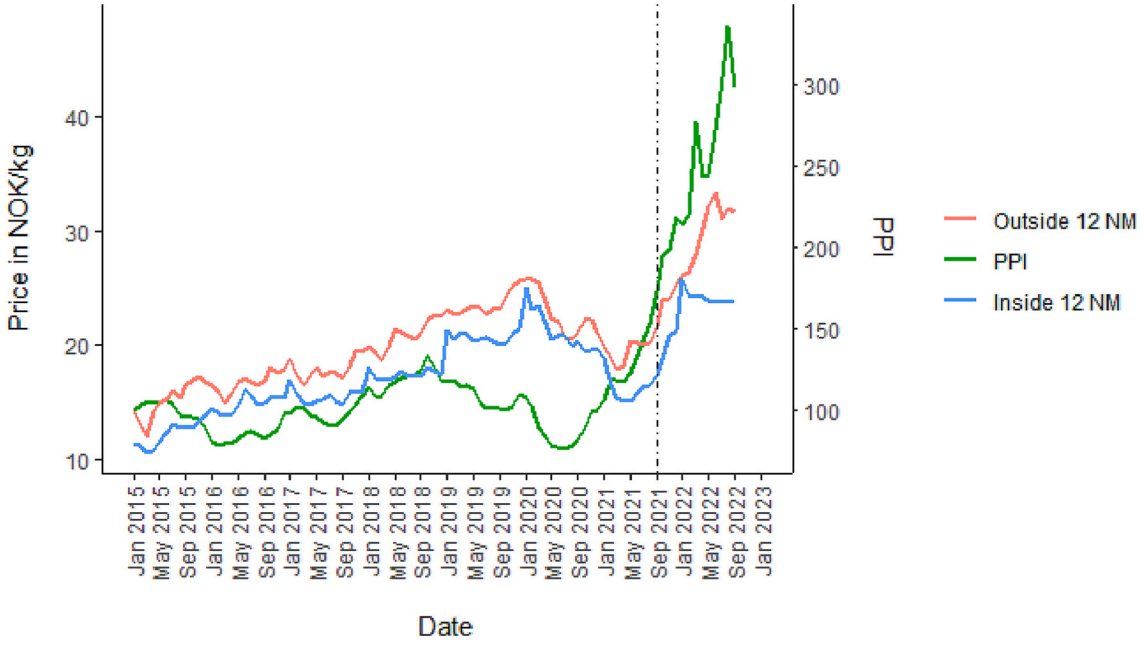

Fig. 3. The average monthly nominal prices of cod caught outside and within territorial waters from 2015 to September 15, 2022, and the trend in the PPI over the same period. The start of the MSC suspension is indicated by the dotted line. Source: NFSO and Statistics Norway.

Table 2
Average prices of cod with and without MSC certification.

	Before MSC suspension (Jan 2015–August 15, 2021)	After MSC suspension (August 16, 2021–September 2022)	Mean difference
Outside 12 nm (Control)	16.34	10.23	6.11
Inside 12 nm (Treatment)	15.31	9.11	6.20
Difference-in-Difference			−0.10***
Mann–Whitney test			66.67***

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

should provide a market-based incentive, in terms of higher prices, for fishers to improve harvesting standards and management (Roheim et al., 2018). Several studies show that there is a premium for MSC at the consumer level (Asche et al., 2015; Asche and Bronnmann, 2017; Sogn-Grundvåg et al., 2014, 2013). However, the results are mixed as to whether the premiums move upstream, and whether fishers experience any market incentives (Wakamatsu, 2014; Stemle et al., 2016; Fernández Sánchez et al., 2020; Blomquist et al., 2015; Blomquist et al., 2020; Andersson and Hammarlund, 2023). The absence of upstream premiums is a significant challenge for the MSC ecolabel, as fishers may lack incentives to be certified without them.

In our case, the Norwegian cod fisheries differ from the subjects of most of the earlier studies in that they are much larger and only a part of the fishery lost MSC certification. Our results indicate that there is a premium associated with the MSC label in the simplest model, but the premium disappears when other factors are controlled for. This suggest that the buyers of MSC-labeled fish are purchasing higher-quality fish at a higher price, as also found by Blomquist et al. (2015). Hence, in this fishery, there was no premium for fishers associated with MSC certification.

Importantly, there was a significant decline in the price paid for non-MSC cod by one group of buyers, the fillet producers. As a significant share of their sales goes to Northern Europe, a region where MSC certification is important, this is not too surprising, and it gives credibility to the argument that MSC labeling gives access to some higher-paying markets. This also supports the notion that MSC certification is important for some buyers in some markets, as it enables them to serve these market segments. The fact that the removal of the MSC certification has no impact on the price in general indicates that the fillet buyers were not a sufficiently important group to influence the price determination process facing the fishers. That price premiums for MSC certification vary with fish size, as observed by Blomquist et al. (2020) for Baltic cod, is consistent with our results, because different fish sizes are typically used for different fish products and markets, and fillet producers tend to use smaller cod.

The existing literature has shown that consumers have various motivations for purchasing ecolabeled seafood and that there are also groups of consumers who do not buy ecolabeled seafood (Fonner and Sylvia, 2015; Ankamah-Yeboah et al., 2020; Tian et al., 2022).[7] This includes motivations that have nothing to do with the state of the fish resource itself, which is most clearly illustrated by consumers motivated by a warm-glow effect associated with purchasing ecolabeled seafood (Bronnmann et al., 2021). Similar motivations also exist at other levels in the supply chain, as Sogn-Grundvåg et al. (2019) found that motivations for buyers in the supply chain were related to cost and not environmental status. These findings underscore the challenges facing the sustainable seafood movement when there is a significant number of buyers with different motivations. While some consumers are willing to pay a premium for sustainably provided fish, there appear to be too many consumers and market channels where certification is not required. The absence of MSC premiums indicates that buyers who require sustainable seafood have an ample supply of fish available and can find alternative sources with relative ease, even if up to 50% of Norwegian cod were to lose MSC certification. When it is not the fishers themselves who pay for the certification process, as is the case for cod in

[7] This is not unique to seafood but is also prevalent in other food products (Onozaka and McFadden, 2011).

Table 3
Parameter estimates and price premiums.

Variables	Model 1	price premium in %	Model 2	price premium in %	Model 3	price premium in %
Within 12 nm	−0.066***	**−6.41**	−0.016**	**−1.58**	−0.016**	**−1.58**
	(0.001)		(0.008)		(0.008)	
Post	−0.452***	**−36.37**	−0.268***	**−23.52**	−0.269***	**−23.58**
	(0.002)		(0.011)		(0.011)	
Loss of MSC (DID)	−0.041***	**−10.15**	0.011	**−0.44**	0.029***	**1.27**
(within 12 nm*post)	(0.002)		(0.007)		(0.010)	
Gear base: Line						
Autoline			0.026***	**2.61**	0.024**	**2.45**
			(0.010)		(0.010)	
Gillnet			−0.044***	**−4.34**	−0.045***	**−4.36**
			(0.007)		(0.007)	
Jig			−0.027***	**−2.63**	−0.027***	**−2.62**
			(0.006)		(0.006)	
Demersal seine			0.036***	**3.62**	0.036***	**3.64**
			(0.008)		(0.008)	
Bottom trawl			0.040**	**4.12**	0.039**	**3.98**
			(0.018)		(0.018)	
Other			0.002	**0.19**	0.001	**0.13**
			(0.017)		(0.017)	
Size: base: 2.5–6 kg						
>6 kg			0.022***	**2.18**	0.021***	**2.16**
			(0.005)		(0.005)	
1–2.5 kg			−0.058***	**−5.64**	−0.058***	**−5.62**
			(0.006)		(0.006)	
Unknown size			0.104***	**10.95**	0.105***	**11.04**
			(0.020)		(0.020)	
<1 kg			−0.181***	**−16.54**	−0.180***	**−16.48**
			(0.012)		(0.013)	
Quality base: A quality						
Downgraded quality			−0.422***	**−34.44**	−0.422***	**−34.45**
			(0.020)		(0.020)	
Extra quality			0.349***	**41.81**	0.348***	**41.69**
			(0.016)		(0.016)	
Landing area base: Area 5						
Area 1			−0.019*	**−1.91**	−0.019*	**−1.87**
			(0.011)		(0.011)	
Area 2			−0.031***	**−3.06**	−0.031***	**−3.05**
			(0.006)		(0.006)	
Area 3			−0.003	**−0.31**	−0.003	**−0.61**
			(0.006)		(0.006)	
Area 4			−0.014***	**−1.42**	−0.015***	**−1.49**
			(0.006)		(0.006)	
Areas 6–9			−0.113***	**−10.66**	−0.113***	**−10.67**
			(0.010)		(0.010)	
Conservation base: fresh						
Frozen			0.262***	**29.99**	0.264***	**30.19**
			(0.018)		(0.018)	
Buyer type, base: conventional buyer						
Other buyers			−0.011	**−1.08**	−0.010	**−1.02**
			(0.010)		(0.011)	
Fresh fish buyers			0.013***	**1.28**	0.016***	**1.58**
			(0.005)		(0.005)	
Fillet buyers			0.026***	**2.68**	0.032***	**3.25**
			(0.006)		(0.006)	
Traders			−0.041***	**−4.03**	−0.039**	**−3.83**
			(0.014)		(0.016)	
Quarter base: Q1 (January–March)						
Q2 (April–June)			−0.028***	**−2.72**	−0.028***	**−2.74**
			(0.003)		(0.003)	
Q3 (July–September)			−0.047***	**−4.58**	−0.047***	**−4.58**
			(0.007)		(0.007)	
Q4 (October–December)			−0.021**	**−2.03**	−0.021**	**−2.07**
			(0.010)		(0.010)	
Year base: 2015						
2016			0.465***	**59.27**	0.465***	**59.26**
			(0.009)		(0.009)	
2017			0.354***	**42.49**	0.354***	**42.49**
			(0.009)		(0.009)	
2018			0.336***	**39.95**	0.336***	**39.93**
			(0.009)		(0.009)	
2019			0.538***	**71.26**	0.538***	**71.24**
			(0.010)		(0.010)	
2020			0.817***	**126.47**	0.817***	**126.46**
			(0.009)		(0.009)	

(*continued on next page*)

Table 3 (*continued*)

Variables	Model 1	price premium in %	Model 2	price premium in %	Model 3	price premium in %
2021			0.221***	**24.71**	0.221***	**24.71**
			(0.012)		(0.012)	
2022			0.146***	**15.67**	0.146***	**15.66**
			(0.016)		(0.016)	
Interaction effect: loss of MSC*buyer type						
Loss of MSC*other buyers					−0.010	**0.31**
					(0.013)	
Loss of MSC*fresh fish buyers				−0.027	**−1.39**	
					(0.016)	
Loss of MSC*fillet buyers					−0.060***	**−4.78**
					(0.014)	
Loss of MSC*trading buyers					−0.022	**−0.94**
					(0.022)	
Constant	2.754***		2.404***		2.402***	
	(0.001)		(0.009)		(0.008)	
Observations	1,454,729		1,454,729		1,454,729	
R^2	0.260		0.850		0.850	

Clustered robust standard errors in parentheses.
*** p < 0.01, ** p < 0.05, * p < 0.1.

Table 4
Significance of main effects.

Null Hypothesis	Test Statistic	Distribution	Prob > F
No effect of within 12 nm	4.34	F(1,406)	0.0379
No effect of post	563.22	F(1,406)	<0.001
No effect of loss MSC (DID)	8.01	F(1,406)	0.0049
No effect of gear	27.88	F(6,406)	<0.001
No effect of size	85.39	F(4,406)	<0.001
No effect of quality	507.39	F(2,406)	<0.001
No effect of frozen	205.64	F(1,406)	<0.001
No effect of landing area	28.58	F(5,406)	<0.001
No effect of buyer type	10.65	F(4,406)	<0.001
No effect of buyer type × DID	7.50	F(4,406)	<0.001

Norway,[8] the certification becomes a free option. Hence, if buyers are willing to pay the chain-of-custody certification, there are no other costs to be paid by the agents involved in the transaction.

In the broader literature, the adoption of an ecolabel by producers is motivated by the potential profitability it brings. However, unlike in terrestrial and aquaculture farming, where it is individual farms that are certified (Roe and Sheldon, 2007; Osmundsen et al., 2020), in fishing, certification is granted to the entire fishery due to its status as a common pool resource. Hence, a positive effect of certification in this setting is that the environmental and informational benefits that are associated with certification accrue regardless of whether individual fishers use the ecolabel or not (Roheim et al., 2018). This contrasts with farming, where the decision to adopt more sustainable practices is an individual choice, and when such practices are adopted, the benefits occur only on the specific farm.

Hence, it is important to note that the loss of ecolabel certification has significant consequences at the fishery level, leading to potential environmental impacts at that same scale. Additionally, individual producers lose the opportunity to target market segments that require or provide a premium for ecolabel certification. The fact that several fisheries have withdrawn from or opted not to renew their MSC certification provides further evidence that certification is not profitable for all fisheries (Pierucci et al., 2022). This implies that there may be an oversupply of certified fish that surpasses the actual market demand.

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.

Data availability

Data will be made available on request.

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Appendix A. Appendix

Table A1. ANOVA test statistic and effect size estimations.

	Partial SS	df	MS	F	Prob>F	partial ω2
Model	126,828.97	39	3252.025	210,000.00	0.0000	0.8502
Within 12 nm	17.510555	1	17.51056	1140.32	0.0000	0.0008
Post	714.9217	1	714.9217	46,556.93	0.0000	0.0310
Loss of MSC	9.0943453	1	9.094345	592.24	0.0000	0.0004
Autoline	13.441088	1	13.44109	875.31	0.0000	0.0006
Gillnet	283.06797	1	283.068	18,433.87	0.0000	0.0125

(*continued on next page*)

[8] In Norway, the initial MSC certification of the cod fishery was paid for by the Norwegian Seafood Council. The Norwegian Fishermen's Association has paid for recertifications.

(*continued*)

	Partial SS	df	MS	F	Prob>F	partial ω2
Jig	89.027204	1	89.0272	5797.60	0.0000	0.0040
Demersal Seine	105.10254	1	105.1025	6844.46	0.0000	0.0047
Bottom trawl	12.755286	1	12.75529	830.65	0.0000	0.0006
Other	0.008217	1	0.008217	0.54	0.4645	0.0000
>6 kg	104.01027	1	104.0103	6773.33	0.0000	0.0046
1–2.5 kg	712.63662	1	712.6366	46,408.12	0.0000	0.0309
Unknown size	52.867296	1	52.8673	3442.81	0.0000	0.0024
<1 kg	851.45659	1	851.4566	55,448.32	0.0000	0.0367
Downgraded quality	7623.1224	1	7623.122	500,000.00	0.0000	0.2544
Extra Quality	123.25405	1	123.2541	8026.52	0.0000	0.0055
fresh	608.14502	1	608.145	39,603.45	0.0000	0.0265
Area 1	31.019598	1	31.0196	2020.05	0.0000	0.0014
Area 2	133.13222	1	133.1322	8669.80	0.0000	0.0059
Area 3	1.3021368	1	1.302137	84.80	0.0000	0.0001
Area 4	26.028342	1	26.02834	1695.01	0.0000	0.0012
Areas 6–9	1053.3992	1	1053.399	68,599.17	0.0000	0.0450
Other buyer	5.6819241	1	5.681924	370.02	0.0000	0.0003
Fresh fish buyer	41.062218	1	41.06222	2674.04	0.0000	0.0018
Fillet buyer	131.75869	1	131.7587	8580.35	0.0000	0.0059
Trader	21.714286	1	21.71429	1414.07	0.0000	0.0010
Q2	189.92174	1	189.9217	12,368.03	0.0000	0.0084
Q3	222.64157	1	222.6416	14,498.80	0.0000	0.0099
Q4	44.339051	1	44.33905	2887.44	0.0000	0.0020
2016	22,468.953	1	22,468.95	1,500,000.00	0.0000	0.5015
2017	12,851.763	1	12,851.76	840,000.00	0.0000	0.3652
2018	11,231.957	1	11,231.96	730,000.00	0.0000	0.3346
2019	26,111.854	1	26,111.85	1,700,000.00	0.0000	0.5389
2020	61,406.787	1	61,406.79	4,000,000.00	0.0000	0.7333
2021	4236.2298	1	4236.23	280,000.00	0.0000	0.1594
2022	384.18554	1	384.1855	25,018.82	0.0000	0.0169
Loss of MSC × other buyer	0.9541121	1	0.954112	62.13	0.0000	0.0000
Loss of MSC × fresh fish buyer	18.056698	1	18.0567	1175.88	0.0000	0.0008
Loss of MSC × fillet buyer	56.648064	1	56.64806	3689.02	0.0000	0.0025
Loss of MSC × traders	1.0400551	1	1.040055	67.73	0.0000	0.0000
Residual	22,338	1,454,689	0.015356			
Number of obs.	1,454,729					
R-squared	0.8502					
Root MSE	0.123919					
Adj. R-squared	0.8502					

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