MARKET POWER IN NORWEGIAN SALMON INDUSTRY

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Summary

The increase in demand for salmon internationally and limited production possibility of that in specific regions of the world increase the concern of lower market competitiveness in this industry. However, as the concentration in the international distribution of salmon has increased simultaneously on the side of other actors of the global value chain, the availability of market imperfection is not obvious anymore which gives the opportunity to test this issue. In this study, we have used the mark-up and Lerner index approach to test the market imperfection in Norwegian salmon industry. The financial data of large enterprises are used for this analysis. The results show that a level in imperfection can be observed in production/processing industry. However, this imperfection is not stable and it can be affected as the cost of production increases which can be affiliated to disease outbreak in sea farm.

Key words: market power, mark up, Lerner index, salmon, Norway

1 Introduction

Salmon is one of the major aquaculture products which can be produced in limited coastal areas of the world. This is because of some biological/morphological characters of this species. In 2018, from total 2.36 million tonnes farmed salmonids production in the world (MOWI, 2019), 1.25 million tonnes was produced in Norway (KONTALI, 2019). Due to biological constraints, seawater temperature requirements and other natural constraints, farmed salmon is only produced in Norway, Chile, UK, North America, Faroe Islands, Ireland, New Zealand and Tasmania (MOWI, 2019). Chile with more than 0.6 million tonnes is at the second level (MOWI, 2019). Therefore, Norway plays an important role on international Salmon market. The EU is the largest import market for salmon products globally (EUMOFA, 2017). Norway exported 736,000 tonnes of salmon to the EU in 2017 and is the main source of EU fish-product imports. These imports mainly consist of fresh whole products originating from Norway, and entering into the EU through Member States that act as "trade routes", namely Sweden and Denmark[1].

This structure of demand market shows that the available natural monopoly on salmon production is not the only argument to claim that a market power is available in salmon supply chain. The major customers of Norwegian salmon are huge European supermarket chains which have a certain level of bargaining power (OLAFSDOTTIR et al., 2019) . By applying market power analysis on different part of salmon supply chain, we can explore a possible concentration in that chain and find the market imbalances. Analysing the structure of salmon industry in Norway is the first step to see how the concentration is developed in this supply chain. In this paper we use mark-up approach to test the concentration and power imbalances in Norway Salmon industry. In section 2, we will analyse the salmon industry in Norway. The literature review on market concentration is presented in section 3. Data and methodology are

[1] EUMOFA (2017). The EU Fish Market. 2017 Edition.

presented in section 3. Later on results are presented. Finally there will be discussion and conclusion.

2 Salmon industry in Norway

The available statistics shows that the majority of farmed salmon in Norway is produced by large companies. Large enterprises refereed to enterprises with more than 6 official licences for harvesting salmonids (KONTALI, 2019). Table 1 shows the structure and development of license ownership in Norway.

Table 1: The structure of license distribution between enterprises and its development during 1994-2018

		1994	2002	2006	2014	2016	2018
No of Enterprises with different licenses	1 licenses	221	45	34	14	13	13
	2-5 licenses	130	95	80	52	47	48
	6-10 licenses	9	15	9	15	18	20
	> 10 licenses	5	15	19	20	21	21
Total number of licenses		692	760	889	1057	1123	1165

Source: KONTALI (2019)

As table 1 shows, the number of licenses which were issued during 1994-2018 has increased and mainly belong to larger enterprises. There are three types of production licenses which include Regular Concession, Development Concession or Green Concession (EUMOFA, 2017). Aquaculture licenses are granted in allocation rounds determined by the Ministry. Applicants with the highest bids are granted the licenses. Furthermore, the government is supporting the sustainable growth of aquaculture and has published a strategy for competitive Norwegian aquaculture industry (MFCA, 2007). The license states the maximum level of salmon the fish farmer can have in the sea at any time during the production process. The level is named the maximum allowed biomass (MAB) and is settled in tons of fish (biomass). The MAB regulation is valid both on the company level and for the specific production site (DIRECTORATE OF FISHERIES, 2019) . The development licenses are awarded for facilitating development of new technologies to reduce environmental footprint or territorial challenges in the aquaculture industry. By considering the utilization of the MAB, we can have more clear idea on the role of different actors in Norway salmon industry. MAB is measured by the average harvest quantity per standard license over the last two years. On average, one standard license represents 780 tonnes on salmon harvest. Table 2 shows the important of large and small enterprises in Norway salmon industry (MARINEHARVEST, 2018).

Selling a commodity where demand is bigger than supply and market is free and open, including effective logistic and transaction cost leaves the power to primary producers. Norwegian salmon (fresh or frozen, whole or fillet are sold in a B to B negotiations on weekly basis. Wholesalers from all the main consumer markets (Europe mostly) are buying whole truck loads either directly or through Norwegian wholesalers as representatives for a European wholesaler or secondary producer in Europe. It is estimated that around 60% of the volume is sold on such spot market conditions to the highest bidder (OLAFSDOTTIR et al., 2019). However, there is an emergence of long-term contractual supplier–customer relationships between large aquaculture-producing companies and secondary processors or retail in Europe (OLAFSDOTTIR et al., 2019). Smaller producers usually do not have direct contractual relations with retailers. This implies that smaller companies may be in better position to take advantage of profit opportunities that price variability offer, compared to larger companies who are more likely to be engaged in contracts (ASCHE, SIKVELAND, & ZHANG, 2018).

Table 2: The breakdown of salmon industry base on the size of the licenses and the harvest capacity 2018.

Company	NO of licenses	MAB	MAB distribution
Large companies (6 or more licenses)	982	807180	84%
Small & Mid-sized companies (1-5 licenses)	165	131173	14%
Other, not commercial	18	16908	2%
Total	1165	955261	100%

Source: KONTALI (2019)

Salmon from Norway is a homogeneous commodity product and exported from Norway mainly as head on gutted whole fresh fish. There is a minimum standard differentiation of quality i.e. superior or ordinary base on production quality, but primary producers in Norway have to sell by price only. The competitive edge for primary producers of global commodity products therefore remains to cost efficiency in production (getting the biggest possible margin per produced unit). In average, Norwegian producers have for a long period had good margins for their products and have been leading in the implementation of technology and up to now been the most cost- effective producers globally. However, structural changes and vertical integration in the chain, where large Norwegian producers have subsidiaries in different countries, can further influence the power balance in the salmon value chain (OLAFSDOTTIR et al., 2019). That was the motivation to use mark-up approach to test then market imbalances among producers.

3 Literature review

The issue of concentration in salmon industry and approaches to measure that was a topic of interest during last last 30 years. By considering the global development of agri-food supply chain, we can observe that the emergence of powerful food retailers, along with continued increases in concentration among food manufacturers, raises issues of bilateral oligopoly and countervailing power in whole sale market (SEXTON & XIA, 2018). The concentration in the agri-food chains is mainly fuelled by increasing consolidation and vertical coordination in the value chain and by worldwide food price inflation and volatility 2007-2008 (McCORRISTON, 2014). As mentioned earlier, the Salmon farming has a special character that is limited to certain areas of the world. The concerns on concentration in salmon industry is an old one and it has emerged as the farmed salmon industry started to grow immensely in Norway. As one of the early studies, DEVORETZ & SALVANES (1993) have used the price discrimination model to analyse the supply–demand equilibrium of the salmon market. Using the Norwegian salmon trade data between 1983-1988, they showed that Norwegian exporters have limited ability to engage in regional price discrimination. Nevertheless, seasonal price discrimination may have taken place because demand was more inelastic in periods when fresh wild-caught salmon were unavailable. KVALØY & TVETERÅS (2008) have used a theoretical model of average cost (AC) curve to analyse the vertical integration in salmon industry. They concluded that the farming and processing stages in salmon industry have become more capital intensive, which has led to a steeper U-shaped average cost (AC) curve. Their model showed that in a context of repeated game model of relational contracting, when the AC curve is sufficiently steep, then processors and farmers are more likely to vertically integrate. The reason is that steep AC curves make it costly to deviate from the optimal production scale, which in turn makes processors more vulnerable to opportunistic behaviours from its suppliers. By considering the further development in Salmon industry and available statistics, ASCHE et al. (2013) has shown that in Norway, production per license has increased from 26 tons in 1980 to 1130 tons in 2010, suggesting a substantial intensification in the industry. Additionally, they have shown in all five leading salmon producing countries, the degree of concentration has increased and the large firms have become bigger over time. The development of salmon industry and its supply chain also studied in other parts of the world with focus on other actors in the supply chain. XIE & ZHANG (2014) studied the level competition in the US salmon import market using a residual demand model. Monthly trade data between US, Chile and Canada from January 1995 to December 2012 are applied for this estimation. The estimation results explain the jointly dominant positions of Chilean and Canadian salmon exporters in the US salmon import market. Additionally, estimation results indicate that the profit margin of Canadian whole salmon was substantially higher during the period when the antidumping order (AD) measure was imposed on Chilean salmon and after the infectious salmon anemia (ISA) outbreak. FOFANA & JAFFRY (2008) used the average quarterly 1992-2004 prices for smoked, fillet, and whole salmon at the retail and wholesale level in UK to test the oligopsony power in the chain. This was a response to concern on increase of concentration in the UK salmon retail sub-sectors. They used dynamic error correction translog profit function to model the behaviour of retailers in the input market for smoked, fillet, and whole salmon with Bayesian technique. The final estimated indices of market power in the models were low and statistically significant but sufficiently closer to the perfect competition benchmark indicating that retailers as a whole behaved competitively during much of the period covered by this study.

As we can see different results and conclusion found in the available studies on Salmon market. This was our motivation to apply a novel approach of KUMBHAKAR, WANG, &

HORNCASTLE (2015) in market power analysis to shed light on the latest concentration changes on the side of production and processing in Salmon industry of Norway.

4 Data and methodology

4.1 Theoretical model

We follow the methodology developed by (BRESNAHAN, 1982, 1989) and MUTH & WOHLGENANT (1998) to test for the market imperfections. The model is derived using the conjectural variation approach and under the behavioural assumption of profit maximization. The optimization problem can be introduced as follows. The profit function of i-th processor is:

(1) $\pi_i = p \cdot y_i - C(\mathbf{w}, y_i, t)$

where p is a price of output, y_i is the output of i-th processor, **w** is a vector of input prices, and $C(w,y_i,t)$ is a cost function of i-th processor. Time trend (t) captures technical change.

If the inverse demand function is:

(2) $y = f(p, \mathbf{d})$ or $p = f^{-1}(y, \mathbf{d})$,

where **d** is a vector of demand shifters and y is the total demand for food, then given (1), the first-order condition for profit maximisation is:

(3) $$\frac{\partial f^{-1}(y,\mathbf{d})}{\partial y} \cdot \frac{\partial y}{\partial y_i} \cdot y_i + p - \frac{\partial C(\mathbf{w}, y_i, t)}{\partial y_i} = 0$$

which can be written as:

(4) $$p \cdot \left(1 + \frac{\Omega}{\varepsilon_p}\right) = \frac{\partial C(\mathbf{w}, y_i, t)}{\partial y_i} \quad ,$$

where $\varepsilon_p = \dfrac{\partial y}{\partial f^{-1}(y,\mathbf{d})} \cdot \dfrac{p}{y} < 0$ is a demand elasticity of the output and $\Omega = \dfrac{\partial y}{\partial y_i} \cdot \dfrac{y_i}{y}$ is a conjectural elasticity. The conjectural elasticity indicates the degree of market power. In particular, the elasticity lays in the interval $\Omega \in [0;1]$. Whereas $\Omega = 0$ represents competitive behaviour, $\Omega = 1$ characterizes monopolistic power. That is, significant positive value of Ω indicates the presence of non-competitive behaviour in the output market. In particular, the higher is Ω, the greater is the degree of non-competitive behaviour or market power imbalances in general, respectively.

Relation (4) suggests that:

(5) $$p \geq \frac{\partial C(\mathbf{w}, y_i, t)}{\partial y_i} \quad \text{for} \quad \Omega \in [0;1].$$

Expanding both sides of the relation by the y/C:

$\frac{py_i}{C_i} \geq \frac{\partial C(w,y_i,t)}{\partial y_i}\frac{y_i}{C_i}$, and expressing $\frac{\partial C(w,y_i,t)}{\partial y_i}\frac{y_i}{C_i} = \frac{\partial lnC}{\partial lny_i} = \frac{\partial D^I}{\partial lny_i}$

where the last equality comes from the duality of the cost (C) and input distance (D^I) functions (SHEPHARD, 1970), we get:

(6) $\frac{py_i}{C_i} \geq \frac{\partial lnD^I}{\partial lny_i}$

4.2 Empirical strategy

Inequality in (6) can be transformed into equality by adding a non-negative one-sided term, u:

(7) $\frac{p \cdot y}{C} = \frac{\partial \ln D^I}{\partial \ln y} + u \ , \quad u \geq 0 \, .$

Assuming that the input distance function has a translog form:

(8)
$$\ln D^I = \alpha_0 + \alpha_t t + \frac{1}{2}\alpha_{tt} t^2 + \alpha_y \ln y + \alpha_{yt} \ln yt + \frac{1}{2}\alpha_{yy} (\ln y)^2$$
$$+ \boldsymbol{\alpha}_x{}' \ln \tilde{\mathbf{x}} + \boldsymbol{\alpha}_{xt}{}' \ln \tilde{\mathbf{x}} t + \frac{1}{2} \ln \tilde{\mathbf{x}}' \mathbf{A}_{xx} \ln \tilde{\mathbf{x}} + \ln \tilde{\mathbf{x}}' \mathbf{A}_{xy} \ln y$$

where $\tilde{x}_j = x_j / x_J$ for j = 1,…,J.

The corresponding first order derivative is:

(9) $\frac{\partial lnD^I}{\partial lny_i} = \alpha_y + \alpha_{yt} t + \alpha_{yy} lny + \boldsymbol{\alpha}_{xy}{}' ln\tilde{\boldsymbol{x}}$.

Consequently, it follows from (7) and (9) that the function to be estimated has the form:

(10) $\frac{py_i}{C_i} = \alpha_y + \alpha_{yt} t + \alpha_{yy} lny + \boldsymbol{\alpha}_{xy}{}' ln\tilde{\boldsymbol{x}} + \mathrm{u}$.

Since we define the relative mark-up as:

(11) $\varphi = \frac{p - MC}{MC}$.

It can be estimated via:

(12) $\varphi = \frac{u}{\partial \ln D^I / \partial \ln y}$, i.e. $\hat{\varphi} = \frac{\hat{u}}{\alpha_y + \alpha_{yt} t + \alpha_{yy} \ln y + \boldsymbol{\alpha}_{yx}{}' \ln \mathbf{x}}$,

or in terms of Lerner index (1934) as:

(13) $L = \frac{P - MC}{P} = \frac{\varphi}{1 + \varphi}$

KUMBHAKAR, BAARDSEN, & LIEN (2012) first applied stochastic frontier approach in the estimation of the degree of market power in (7). The novelty of our study is the use of 4-step procedure to avoid the endogeneity problem and to get unbiased estimate of the one-sided error term associated with the degree of market imperfections (power). In particular, we append to the relation (7) statistical noise (v) and distinguish between transient (ε) and permanent (μ) part of non-negative one sided error term, i.e. $u = \varepsilon + \mu$. Since the market power is a result of firm strategy, which has a long-run nature, only the permanent one sided error term can be associated with the market power. Moreover, considering α_y in (11) as a random parameter that respects differences in firms' technologies α_y represents heterogeneity component in the estimated mark-up model.[2] The conceptual distinction between heterogeneity, transient and permanent one-sided error term is crucial for getting consistent estimate of relative mark-up. The model is mis-specified and the results biased if the model miss one or more of these component. Specifically,

[2] The model specification is an analogy to the 4-component stochastic frontier model (TSIONAS & KUMBHAKAR, 2014).

the model produce an upward bias of one-sided error term if we do not distinguish between firm effects (latent heterogeneity) and the one-sided component (KUMBHAKAR et al., 2015). Moreover, the model provides a upward bias estimate of market power component if transient and persistent parts of one-sided component are not treated separately. Thus, a more rigorous treatment of this issue is necessary and can be considered as another novelty of this paper.

That is, the model to be estimated has a form:

(14) $\frac{py_i}{c_i} = \alpha_{y_i} + \alpha_{yt}t + \alpha_{yy}lny + \boldsymbol{\alpha}_{xy}{}' ln\widetilde{\boldsymbol{x}} + \varepsilon_{it} + \mu_i + v_{it}$,

where subscript i = 1, …, I, refers to the i-th processors and t = 1, …, T denotes time. The distributional assumptions are as follows: $v_{it} \sim N(0, \sigma_v^2)$, $\varepsilon_{it} \sim N^+(0, \sigma_\varepsilon^2)$, $\mu_i \sim N^+(0, \sigma_\mu^2)$ and $\alpha_{y_i} \sim N^+(0, \sigma_\alpha^2)$. Moreover, the components are assumed to be independent of each other and of repressors.

To avoid endogeneity problem in the estimation of (14) and to distinguish among time variant and time invariant one-sided component as well as statistical noise and heterogeneity component we use a 4-step estimation procedure (BOKUSHEVA & ČECHURA, 2017). In the first step, we apply the two-step system GMM (ARELLANO & BOVER, 1995; BLUNDELL & BOND, 1998) estimator to get unbiased parameters of (14). Then, in the second step, the residuals from GMM level equations are employed in the estimate of the random effects model. The next steps provides the estimates of transient, persistent and heterogeneity component.

4.3 Data

Dataset is drawn from two main sources. The list of enterprises are selected from the KONTALI salmon industry report[3]. These are the large enterprises in salmon industry of Norway. Later on the financial data which is reported by this enterprises are extracted from 'Purehelp'[4]. It is a major Norway business search engine. They pile reported financial data from companies. Moreover, the size of salmon harvest and number of licenses are extracted from KONTALI reports for different years. By using the data explained above, we use the following variables in the model: *Revenue share* = Revenue/Costs, *Output (Y)* which is total revenue, and normalized cost of *Material (M)* and *Labour (L)*. Revenue is represented by total revenue (Turnover) of the company. Costs are the sum of *labour costs*, *material costs* and *capital costs*. Labour costs are represented by the costs of employees, material costs by product consumption per company, and capital costs by depreciation. Output is expressed as total revenue (Turnover) of the company and is deflated by the sectoral index of food processing prices (2015 = 100). Material and labour are normalized by capital. Capital is represented by total fixed assets. Material and Capital are deflated by the index of producer prices in the industry (2015 = 100) and Labour by the consumer price index (2015 = 100). Moreover, we rejected producers with fewer than four observations (on average) to comply with the requirements of applied system GMM estimator. For GMM model estimate, input variables were used as instruments lagged up to two periods for the equation in levels and up to three periods for the equation in differences. Then, we used year dummies and total fixed assets as additional instruments.

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[3] https://www.kontali.no/publications/yearly-publications#salmon-farming-industry-in-norway
[4] www.purehelp.no.

5 Results

Table 3 provides a parameter estimate of the mark-up model for salmon producers in Norway. The estimates indicates overall statistical quality of the model. In particular, the fitted parameters for time, output and normalized Labour are statistically significant at 5 % significance level. Moreover, Arellano-Bond test for *AR(2)* in first differences as well as Hansen test of over identified restrictions indicate the validity of the model and the employed instruments, respectively. Finally, the results for the second, third and fourth step of the estimation procedure indicate, in all cases, highly significant estimates of one-sided error terms. In particular, the statistical significance of permanent part of one-sided error component show that the deviations from the competitive market situations are important characteristic of salmon producers' output market in Norway. In other words, we can reject the null hypothesis about no market imperfections in the Norwegian salmon market.

The output and normalized material inputs coefficients indicate a positive impact on the revenue share. On the other hand, labour inputs determine negatively the revenue share. These results suggest that the larger companies may exploit the economies of scale. Moreover, the labour inputs might be replaced by relatively cheaper inputs with increasing size. The time variable *(t)* has a positive indicating the increase in added value and profitability of Norwegian salmon industry which is true until 2015 if we investigate the aggregate figures of the industry.

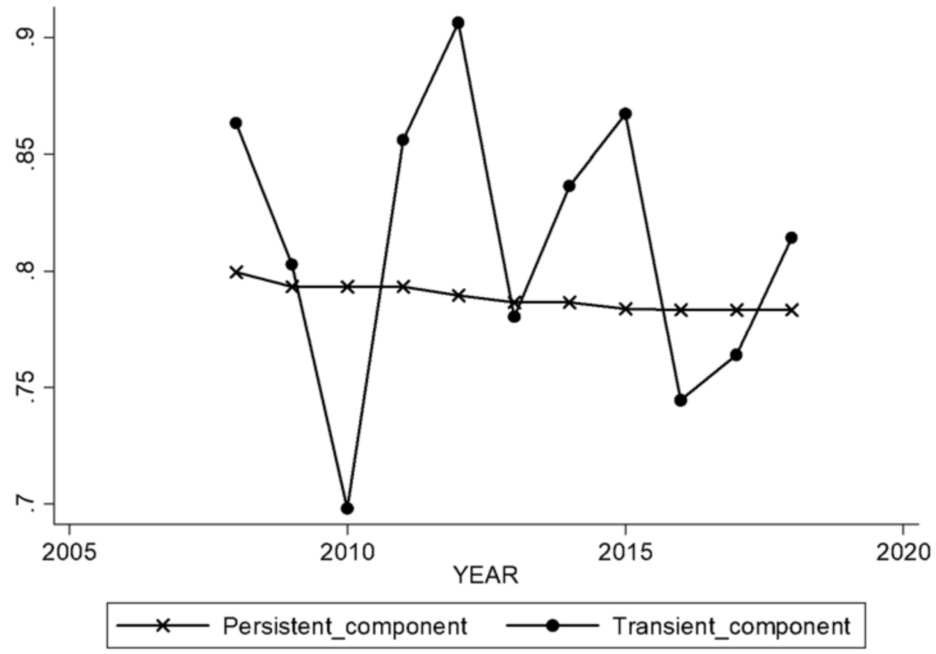
Table 3: Mark-up model

Variable	Coefficient	Std.Dev.	p-value
t	0.025	0.006	0.0000
ln_y	0.055	0.023	0.0220
ln_nL	-0.119	0.058	0.0470
ln_nM	0.030	0.076	0.6890
constant	-0.256	0.463	0.5840
		Test statistics	p-value
AR(2)		-1.91	0.0560
Hansen test of overidentified restrictions: chi2(78)		39.90	1.0000

Source: own calculations

Figure 1 shows that both transient as well as persistent one-sided component indicate significant differences from the perfect competition which is characterized by the identity *P=MC*. The transient component provide the information on short-run deviations which can be related to, for example, contract changes and is expected to be volatile through time. The permanent component might be associated with the measure of market power due to its source in company strategy (summary of results are presented in table 4).

Figure 1: Persistent and transient one-sided component

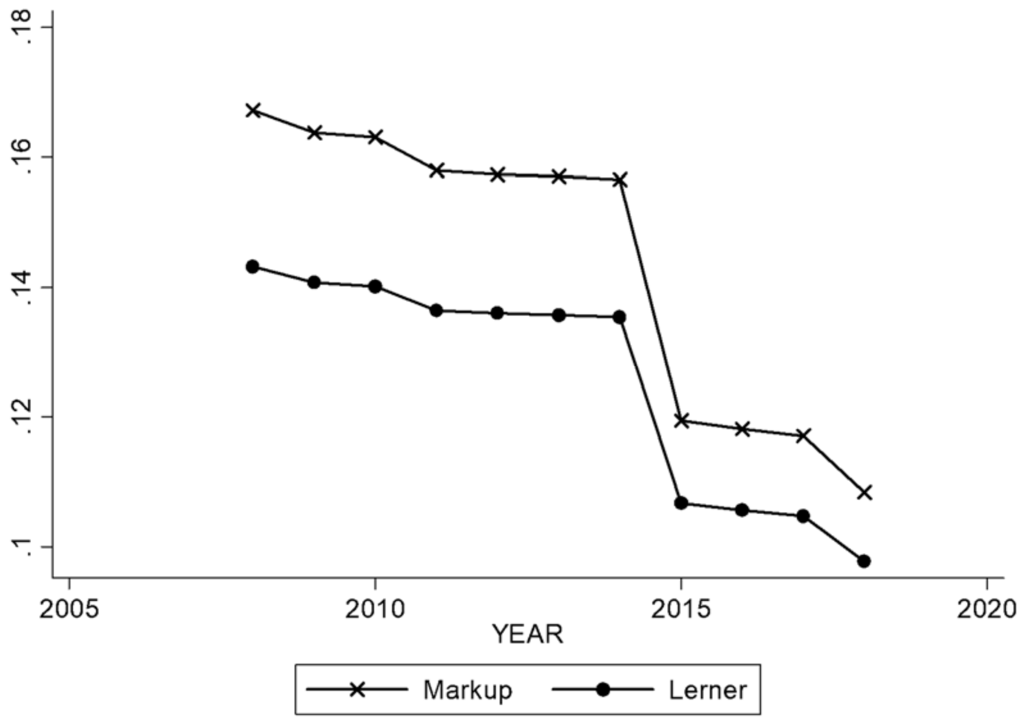


Source: own calculations

Figure 2 and table 4 shows our estimated relative mark-up (equation 11) and Lerner index (equation 13). Both of these parameters show a certain level of concentration among the salmon producers. The Lerner index is in the interval L ϵ (0,1) and it is used as a measure of market power (LERNER, 1934).That is, 0 indicates competitive behaviour and market imperfections increase with increasing Lerner index.[5] Based on these results, we can say that a hypothesis of perfect competition can be rejected. However, as the average range of both parameters between 0.1 and 0.2, and that the distributions are skewed to lower values, we can conclude that a level of oligopoly may be available only for limited number of companies. The interesting part is the slight reduction of these parameters which was not expected. However, by looking to the price development between 2008-2018[6], we see an increase in the prices in 2015. At the same time, the NOK has lost its value vs Euro. Based on the available data reported by KONTALI (2019) and EYGM (2019), the earnings before interest, tax, depreciation and amortization (EBITDA) margin has reduced since 2015. This development is assigned to increase in the cost of production and processing on one side and sea diseases which affect the production and costs. It can be said that this margin reduction has reduced the oligopoly condition of salmon production and processing market in Norway after 2014. It can be expected that technological developments which affect the cost of production or increases the effectiveness the fight with disease, the degree of competitiveness decreases again.

[5] The interpretation of relative mark-up is analogical.
[6] https://www.statista.com/statistics/666053/average-export-price-of-fresh-whole-salmon-from-norway/

Figure 2: Relative mark-up and Lerner index



Source: own calculations

Table 4: Summary statistics of estimated parameters.

Variable	Mean	Std.Dev.	Min.	Max.
Relative mark-up	0.168	0.068	0.000	0.423
Lerner index	0.141	0.051	0.000	0.298
Persistent component	0.788	0.005	0.784	0.800
Transient component	0.809	0.058	0.698	0.906

Source: own calculations

6 Discussion and conclusion

The certain level of market imperfectness was an expected result from salmon production industry in Norway. Nevertheless, this results are accompanied with a group of fact and events for the same period of this study that needs deeper interpretation of the results. The reduction in estimated market power indices (Lerner Index and mark-up) after 2015 could be assigned to increasing cost of salmon production as explained by the industrial reports (EYGM, 2019; KONTALI, 2019). Another event of interest that we have to consider is the Russian import ban of August 2014. Russia had 10% of the Norway salmon market. This event seems to have a negligible effects on the salmon market[7]. However, estimated market power indices reduced. Later on, the price of salmon has increased simultaneously with devaluation of NOK. By considering the reduction of EBITDA which has been observed and reported after 2015, we can conclude that increases in the salmon prices has not covered the increasing production/processing costs. The outbreak of diseases which is observed during the same period can explain this reduction of EBITDA. Therefore, it can be said that the cost efficient technological developments which can appear in the future in the fighting against the diseases can drop the costs of production/processing. This may increase the imperfection to higher levels as before 2015. Moreover, the concentration in this industry can increase as the limited issued production licences can be traded. The concentration of these licences in the hand of few larger actors is another factor of consideration which can increase the economy of scale. Additionally, the robustness of the supply side against shocks such as Russian ban is another factor that shows a cohesive action among major actors of this market. By wrapping up the facts mentioned above, it is not expected that the market imperfectness disappears from salmon supply industry in Norway. However, a certain level of variation in this imperfectness back to possible economic/political or natural events is evitable.

In the next step, we will test the same approach on small companies and exporting companies to see and compare the level of concentration on that side of the supply chain in the future. Additionally, the market power of salmon industry will be tested by price to market approach in the next steps to have a international picture of the market imperfectness. We will try to combine the governance study and market power study to explain the industry in a multidisciplinary approach.

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[7] Russia's trade ban: https://www.seafoodsource.com/features/norway-s-seafood-exports-unscathed-by-russia-s-trade-ban

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