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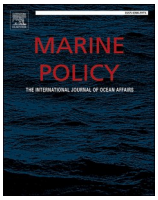

The Covid-19 impacts on the European Union aquaculture sector

Rasmus Nielsen [a,*], Sebastian Villasante [b,c], Jose Manuel Fernandez Polanco [d], Jordi Guillen [e], Ignacio Llorente Garcia [d], Frank Asche [f,g]

[a] Department of Food and Resource Economics, University of Copenhagen, Denmark
[b] Faculty of Business Administration and Management, University of Santiago de Compostela, Santiago de Compostela, Spain
[c] CRETUS, Department of Applied Economics, University of Santiago de Compostela, Santiago de Compostela, Spain
[d] Departamento de Administración de Empresas, Universidad de Cantabria, Avda. Los Castros 56, Santander 39005, Spain
[e] European Commission, Joint Research Centre, JRC, Ispra, Italy
[f] School of Forest, Fisheries and Geomatics Sciences and the Food Systems Institute, University of Florida, 1741 Museum Road, Gainesville, FL 32611-057, USA
[g] Department of Safety, Economics and Planning, University of Stavanger, Ullandhaug, Stavanger 4036, Norway

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ABSTRACT

There have been a number of indications of strong negative impacts of Covid-19 and the preventive measures associated with the pandemic for all food sectors. However, there is increasing evidence that the picture is quite nuanced where the Covid related measures are creating challenges for some and opportunities for others. In this paper we investigate the impacts of Covid-19 on the aquaculture sector in the European Union using two approaches; a survey where industry representatives and experts assess the impacts on key economic indicators allowing for positive as well as negative impacts, and recently published aquaculture production data for Denmark and Spain. Our findings show that surveys' results indicate that, on average, the impact of Covid-19 is negative on the income side, increasing cost and therefore negative with respect to profit. However, in every category the average covers both positive and negative answers suggesting that what was a challenge for some was a window of an opportunity for others. The production data for Denmark and Spain also indicate moderate to no impacts of the Covid-19. The strongest impacts appear on the turbot prices, a species where highly dependent on higher end restaurants. The lower price is a clear indication that there was a significant opportunity cost associated with getting access to other supply chains, particularly as the quantity was also moderately down.

1. Introduction

Beyond the public health consequences, pandemics have affected societies in many ways throughout history, disrupting the social, political, and economic spheres [1-3]. The study of the economic consequences of pandemic outbreaks covers almost all human history, from the ancient era to recent years. These impacts differ across time, countries and industries, mainly due to specific previous differences in terms of efficiency and resilience. However, there are several common effects that may be expected in every crisis, and general trends which may be susceptible to generalization. The various disruptions in the overall economy alter the market conditions causing shifts in the relations among quantities and prices, which finally reach the different economic activities in one way or another. Failures at different levels of the supply chains cause disruptions in production and trade [4], but may also create new opportunities as the disruptions may impact producers, supply chains and consumers differently. This is the case in general, as well as for specific industries like the EU's aquaculture.

While the direct impacts caused by the Covid-19 disease itself are serious, most economic effects are due to the lockdowns and other measures implemented to contain the virus [5]. These have forced several companies to temporarily shut down [6,7], having serious socio-economic effects. But it also created opportunities for suppliers that are able to serve the markets, in line with what is the case with environmental or disease shocks [8,9]. The pandemic measures can also cause demand shocks, positive as well as negative. Demand for some food products initially rose, but preferences shifted towards preserved products [7]. Similarly, the relative importance of different value chains has shifted. For instance, Love et al. [10] show a strong increase in retail demand for seafood in the U.S. that may be large enough to offset the

* Correspondence to: Department of Food and Resource Economics, Rolighedsvej 23, Frederiksberg 1958, Denmark.
E-mail address: rn@ifro.ku.dk (R. Nielsen).

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reduction in seafood demand from restaurants in aggregate. However, the impact may vary by species as different species market shares vary significantly between market segments [11] and producer groups [12, 13].

Aquaculture is a highly dynamic industry. In recent decades innovations in production, logistics and distribution as well as marketing have made it the food production technology with the fastest growth rate [14]. As such, it is an industry where shocks and crises create opportunities as well as challenges, potentially providing a good illustration of Schumpeter's notion of innovation by "creative destruction". In this paper, primary as well as secondary data sources are used for investigating the impacts of the Covid-19 on the aquaculture industries in the European Union (EU). We investigate the industry's main performance indicators, such as sales volume, prices, incomes and costs. The data collection is conducted in two steps. First, interviews with stakeholders and experts provide expectations with respect to indicators of interest, and also allow different perspectives on the impacts of the pandemic measures to be highlighted. These expectations are then related to the available official data and the actual development for key indicators for selected EU aquaculture industries.

There is a rapidly growing literature on the impact of Covid-19 and associated measures, with a main focus on the negative impacts (e.g. [15-17]: van Senten et al., [18]). This literature is often focusing on specific cases and indicators, and clearly shows that the impacts can be dramatic. This paper will show that with a larger perspective, the impacts can be more nuanced. While there certainly are challenges, there are also windows of opportunity and firms willing to exploit them. Overall, that highlights a surprisingly resilient industry.

The paper is organized as follows. In Section 2, an overview of the EU aquaculture industry is presented. Section 3 explains data collection methods and in Section 4 the results of the survey are described. Section 5 includes empirical evidence to support the findings of the survey and

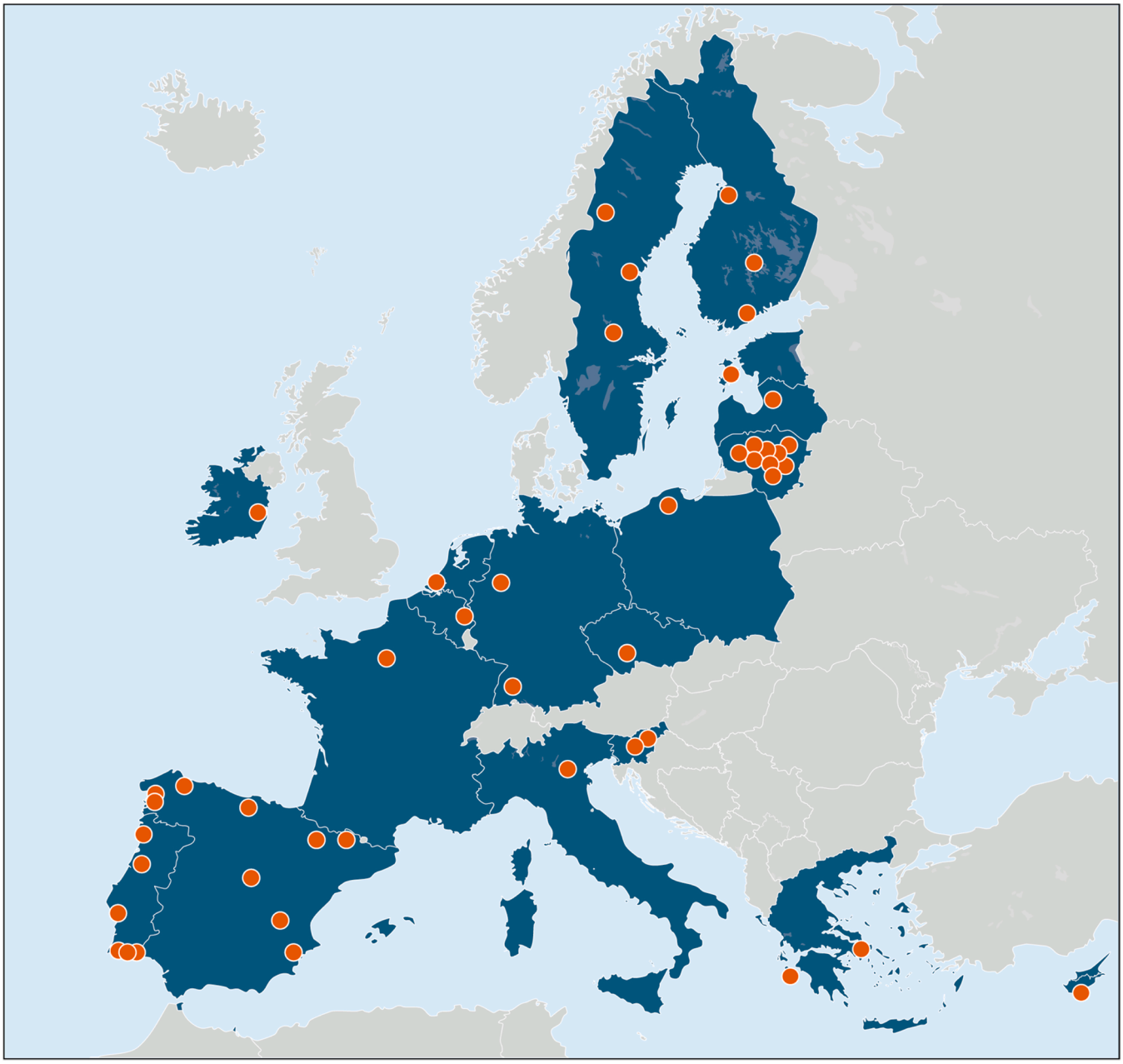

Fig. 1. Origin of the survey responses.
Authors'elaboration based on survey results.

Section 6 discusses and concludes the paper.

2. The EU aquaculture sector

EU's aquaculture production reached almost 1.2 million tonnes and was valued at €4.1 billion in 2018 [19]. The EU aquaculture provides about one fifth of the EU's domestic seafood supply, and has around 15,000 aquaculture enterprises with almost 70,000 employees [19]. Production is concentrated in four countries: Spain, France, Italy, and Greece, making up roughly about 2/3 of all the EU aquaculture production in volume and value.

Aquaculture in the EU can be divided into three main subsectors: Marine finfish, freshwater finfish, and shellfish. The marine finfish sector is the most important economically, generating a production value of €1.8 billion in 2018, followed by the shellfish sector with €1.3 billion and then the freshwater sector with €1 billion [19]. The marine finfish sector is dominated by a few species; seabass, seabream, salmon and sea trout. The freshwater sector is even more concentrated in terms of species as trout and carp dominate total production. The EU shellfish production is more diverse, but it is mainly composed of several species of mussels, oysters and clams.

The EU aquaculture production has been rather stagnant in the last decades; however, the production value has increased together with a slight improvement of the economic performance of the sector. The general low production growth in the EU aquaculture production has often been explained by strict environmental regulations, a high regulatory burden and a top-down approach that do not facilitate economic development [20-24]. Despite this, the aquaculture sector was identified in the EU's Blue Growth Strategy [25] as one of the five sectors with high potential for sustainable jobs and growth. In addition to economic development, the aquaculture sector can also boost food security. Hence, the European Commission, together with the EU member states, have invested significant funds in recent years to increase the EU aquaculture production [26].

When looking at the EU aquaculture sector in more detail, most of the key EU producers increased their production value from 2010 to 2018. The production of seabass, seabream and salmon increased significantly although growth performance vary by country and firm size [27,28]; while the production of mussels, which is the main aquaculture production in volume, declined by 15%. There is not a single cause to explain the mussel production decline in the EU. Mussel production is considered to have declined mainly due to the spread of diseases, algal blooms, lack of mussel seed (spat), predation and low earnings. Such causes may have been exacerbated by local conditions such as the small size of the mussel aquaculture enterprises and the impacts of climate change [29]. The limited control with the production process in mussel aquaculture, as in many other mollusk aquaculture productions, also gives less scope for productivity growth and disease control that has contributed to increased production in aquaculture in general [30,31].

Hence, behind the overall production evolution lies a decrease of species with low economic value (e.g. mussels) only partly due to poor economic performance, and an increase of higher valued species (e.g. salmon, seabass and seabream) with a higher degree of control by the farmer in the production cycle (e.g. feeding, medicines, juveniles, livestock, etc.). This higher degree of control often results in aquaculture managers having to make a wider range of decisions, which may lead to higher flexibility but also higher running costs.

3. Material and methods

Quantitative sources like surveys with statistically representative samples and systematic data collection were not available at the time of analyzing the Covid-19 impacts on the sector. Accurate estimations of the economic impacts of this pandemic usually take time to be obtained with econometric modeling and they are not expected to be available until some years after the pandemic will be over. However, industry and policymakers require, at least, a rapid assessment of the situation to proceed with decision making under the least possible uncertainty. Rapid assessments are usually made to help policy makers and industries to immediately understand the causes and consequences of extreme events (e.g. storms, tsunamis) or other types of abrupt social-ecological shocks (e.g. Covid-19), and to respond to them with a wide range of activities [32]. Despite limitations in statistical representativity, secondary and qualitative information sources provide fast access to the key data and issues and allow providing estimations of the main figures and trends.

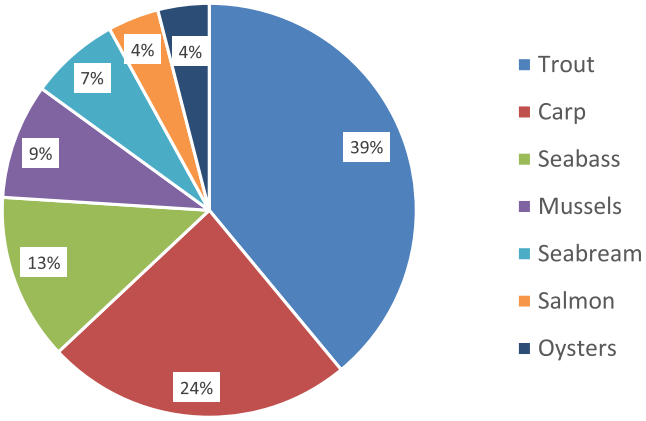

Fig. 2. Most important species produced reported in the survey. Authors'elaboration based on survey results.

To obtain information on the expected impact of the Covid-19 measures, questionnaire-based interviews with selected stakeholders and experts in the EU were conducted. Two groups of interviews were undertaken. First, enterprises and representatives of Producers' Organizations (POs) in the EU were asked to participate in a survey and fill out a questionnaire on the expected effects of Covid-19. Secondly, national experts participating in the economic Working Group for aquaculture under the Scientific, Technical and Economic Committee for Fisheries (STECF) were interviewed.

The first group of interviews were conducted between January 1 and January 31st in 2021. Participants filled in an online questionnaire including several questions about impacts on economic performance and main causes of impacts, plus other general questions about business characteristics and market position. The first group consisted in 58 participants representing enterprises (65%) and producers associations (35%) who contributed replying to the questionnaire in 17 Member States (Belgium, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Slovenia, Spain, and Sweden) (Fig. 1) (See Annex I for the complete information of the survey in the Supplementary Material). The species covered in this group included carp, mussels, oyster, salmon, seabass, seabream, and trout (Fig. 2).

The first part of the survey asks what the respondents role in the industry is. It continues with a series of questions on the range of impacts of Covid-19 on ten economic variables: employment, repair and maintenance, energy costs, raw materials, wages and salaries, costs, turnover, income, prices, sales (volume), where the respondents are given a range of options from more than 50% negative to more than 50% positive. The respondents are then asked to indicate changes to the same categories due to other factors (e.g. disease). Finally, the respondents are asked to indicate the importance of 11 reasons for the Covid-19 impact (including another category), as well as indicate the importance of seven impacts of the COVID 19 pandemic on the health and well-being of aquaculture farmers/workers.

The second group consisted of 20 experts covering other 17 EU countries. The expert's group was requested to provide a brief

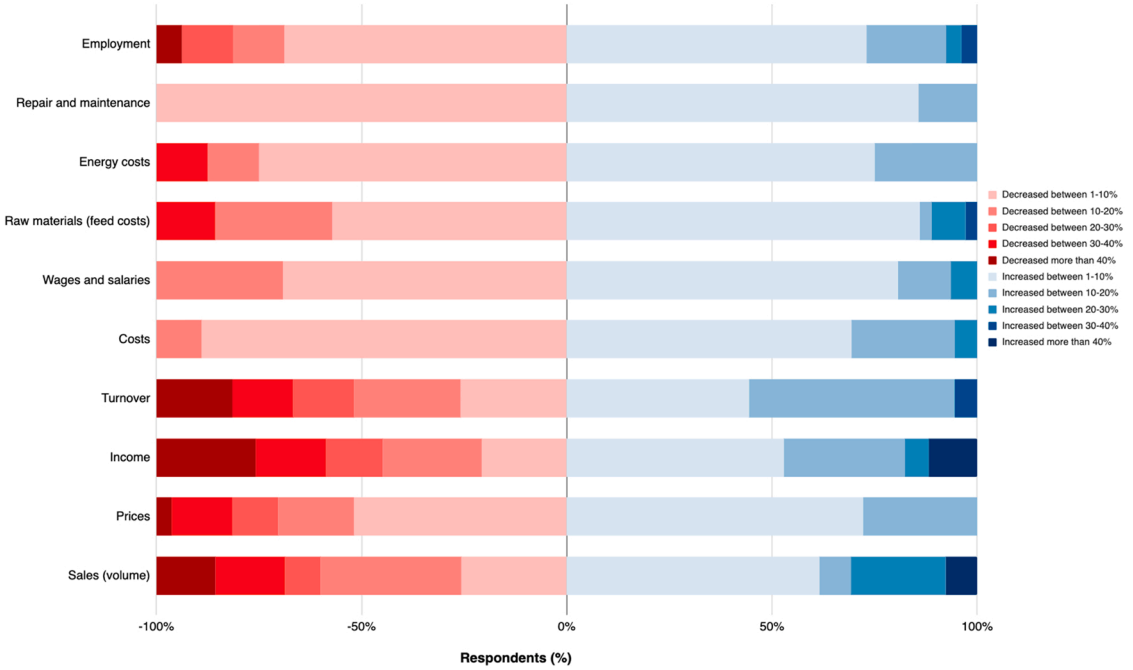

Fig. 3. Impact of COVID-19 on the performance of key economic variables comparing 2019 and 2020.
Authors' elaboration based on survey results.

description of the observed impacts on their national aquaculture industries and participated in a Delphi survey in two waves for estimating the impact ranges in the same key performance indicators analyzed with the producers' group. The expert group was interviewed two times during February 1 and February 5 in 2021. The Delphi method is a systematic and structured technique for assessment of concepts or variables based on the criteria of an experts' panel [33,34]. The Delphi method was originally designed with predictive purposes [35]. The application is based on structured questionnaires answered by a group of selected respondents with experience in the field in two or more waves. After each wave, the results are put in common with the experts, and a new or more waves of the questionnaire are sent to the experts for review and reconsideration. At the end of the process, the experts converge in a common solution to the research questions.

Fig. 1 shows the location of the respondents, and Fig. 2 shows the species produced in the respondents countries. While one cannot claim that the limited sample is representative, the distribution of respondents with respect to home country and species is reflecting the sector in the EU quite well.

As data for all of 2020 is now available for parts of the EU

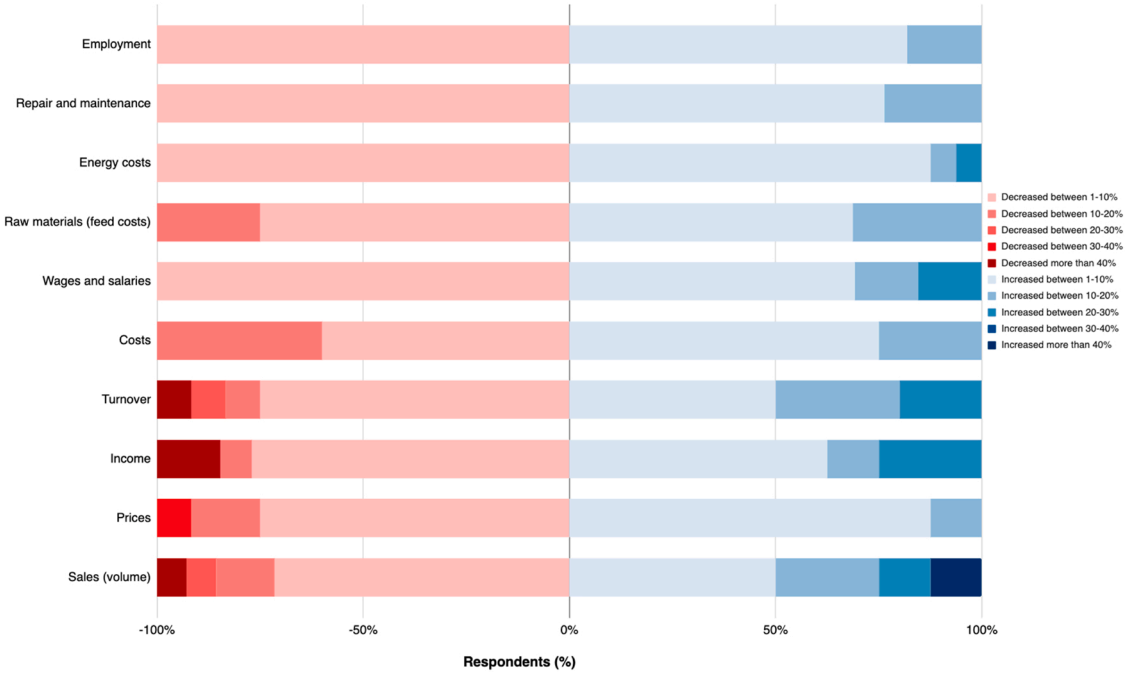

Fig. 4. Impact of other drivers (e.g. environmental changes, diseases, etc.) on the performance of key economic variables comparing 2019 and 2020.
Authors' elaboration based on survey results.

Table 1
Variation estimates in the performance indicators obtained in the participating groups.

	PO's	Enterprises	Experts	Average
Sales volume	-20.00	-15.71	-14.17	-16.63
Prices	-15.00	-3.89	-6.19	-8.36
Total income	-19.38	-20.50	-13.26	-17.71
Turnover	-21.25	-11.50	-11.61	-14.79
Total costs	8.75	5.79	6.56	7.03
Wages and Salaries	0.00	6.84	1.43	2.76
Raw materials	5.33	4.21	5.67	5.07
Energy costs	8.13	2.63	4.63	5.13
Repair and Maintenance	4.38	6.32	5.41	5.37
Employment	-5.71	5.26	0.91	0.15

Source: Survey results

Table 2
Variation estimates in the performance indicators by main aquaculture segments.

	Marine	Shellfish	Freshwater	Average
Sales volume	-3.40	-19.05	-10.34	-10.93
Prices	-3.84	-3.81	-5.55	-4.40
Total income	-8.66	-14.50	-12.30	-11.82
Turnover	-6.48	-13.66	-10.29	-10.14
Total costs	5.52	2.78	7.88	5.39
Wages and Salaries	1.20	0.69	2.15	1.35
Raw materials	2.49	2.72	6.39	3.86
Energy costs	1.60	2.12	4.88	2.87
Repair and Maintenance	3.76	3.93	3.85	3.85
Employment	-0.25	2.55	0.13	0.81

Source: Survey results

aquaculture industry and for trade, we also collected production data for selected industries in Denmark and Spain to show actual impacts on the aggregate level. In the case of Spain, we analyze grow out annual production (volume and value) data for seabream, seabass, turbot, bluefin tuna, rainbow trout and mussels for the period 2016–2020 obtained from the Spanish Ministry of Agriculture, Fisheries and Food [36]. For Denmark, grow out annual production (value and volume) data for rainbow trout and blue mussels for the period 2016–2020 are obtained from the Danish Directorate of Fisheries.

4. Survey results

Fig. 3 shows the responses with respect to how the 10 different economic and social categories are affected in 2020 compared to 2019, with a darker color indicating stronger responses and with red indicating negative and blue indicating positive. One of the most interesting observations is that there are respondents that have opposing perspectives in all categories, that is, the impact of Covid-19 is perceived as negative for some and positive for others. Moreover, there is a tendency that the indicators where some perceive the strongest negative effect, others perceive the strongest positive effect. The indicators on sales volume, prices, income and turnover are the economic variables where most respondents indicate that they are highly negatively affected by the Covid-19 pandemic, while sales volume, income and turnover are also the indicators where there are most respondents perceiving a positive impact. The average sample size of the respondents that reported negative impacts was 18, while the average sample for those who reported positive impacts were 26.

Fig. 4. shows the impact of other factors (e.g. environmental changes, diseases) in the same 10 different economic and social categories. While these are overall weaker than the Covid-19 effects, also here there are respondents with both negative and positive perceptions. Moreover, the strongest effects are for the same indicators as where there are strong Covid-19 impacts, and particularly for sales and income. The average sample size of the respondents that reported negative impacts was 9, while the average sample for those who reported positive impacts were 12.

In Table 1, we report the average percentage point impact for the 10 categories overall as well as for three groups of respondents: PO representatives, firm representatives and STECF experts. For sales volume, prices, incomes and turnover, the average effect is negative, with reductions close to 20%. In the case of operating cost, the effect is positive indicating that total operating costs is expected to increase. It is also notable that the PO representatives perceive a stronger effect than the other two groups for most indicators, and that the industry representatives and the experts seem well aligned.

Due to the decreasing demand, the respondents on average also expected that the prices are reduced. The PO's expects that the decrease will be 15%, whereas enterprises and experts are less pessimistic and expect a decrease in the range of 4% and 6%, respectively. Again, this is most pronounced for fresh perishable products destined for restaurants and hotels [37] and is of less importance for frozen and smoked products [37]. As a consequence of the reduction in sales volume and prices, the turnover and total income are also on average expected to decrease. This decrease is expected to be 18% and 15% for the turnover and total income, respectively.

Looking at the cost estimates, all three respondents groups on average indicate that costs have been increasing (Table 1). The costs are expected to increase at a lower rate than the decrease in income. The PO's expect the largest increase of 9%, whereas enterprises and experts anticipate an increase of 6% and 7%, respectively. On average, the expected increase in total costs is 7%. One of the main contributions to the cost increase stems from extra raw material use. This can for instance be an additional purchase of feed to maintain the fish stock when keeping the fish longer in the farming systems when farmers are waiting for an opportunity to sell their product. Furthermore, the longer production period also affects the cost of energy, repair and maintenance. On average, these three cost items are expected to increase by 5% each.

PO's expect that the increase in costs for the prolonged production period is adjusted through a reduction in the numbers of employees or reduced salaries. In contrast to this, enterprises and experts believe that the extended production period has increased the need for using more labor, which in turn also have increased the cost of wages and salaries. In the labor market structure in most EU countries there is a certain inertia built in, which means that people cannot be laid off from one day to the next. Furthermore, the uncertainty of how long the pandemic will last may postpone hiring and firing of employees.

In Table 2, average impact per indicator is provided by which sector the respondent belongs to. The reason for the differences in the average results between Table 1 and Table 2 is that not all answers from the survey could be distributed on main aquaculture segments and expert answers are not a part of this table. Thus, the number of respondents for the aquaculture segments shown in Table 2 is as follows: *Marine*, includes 11 responses, seabass (6), seabream (3) and salmon (2); *Shellfish* 6 answers, mussels (4) and oysters (2); and *Freshwater* 29 responses, including trout (18) and carp (11); while 3 respondents did not specify the type of species in their answers.

Looking at the three segments, the stronger negative impacts on the income sources appears to be in the shellfish segment showing a decrease in sales volume of 19%. On the other hand, the shellfish sector seems less affected from increasing cost than the other segments. A reason for this is that the additional cost of leaving the shellfish in the water a bit longer does not require extra amounts of feed, but is more related to extra energy cost spent when more repair and maintenance are needed within a prolonged production period. Wages and salaries are expected to increase slightly following an increase in employment. It should be noted that the shellfish segment combines species that are highly differentiated in terms of production and markets, and the on average estimated numbers may significantly change when moving across species and production systems.

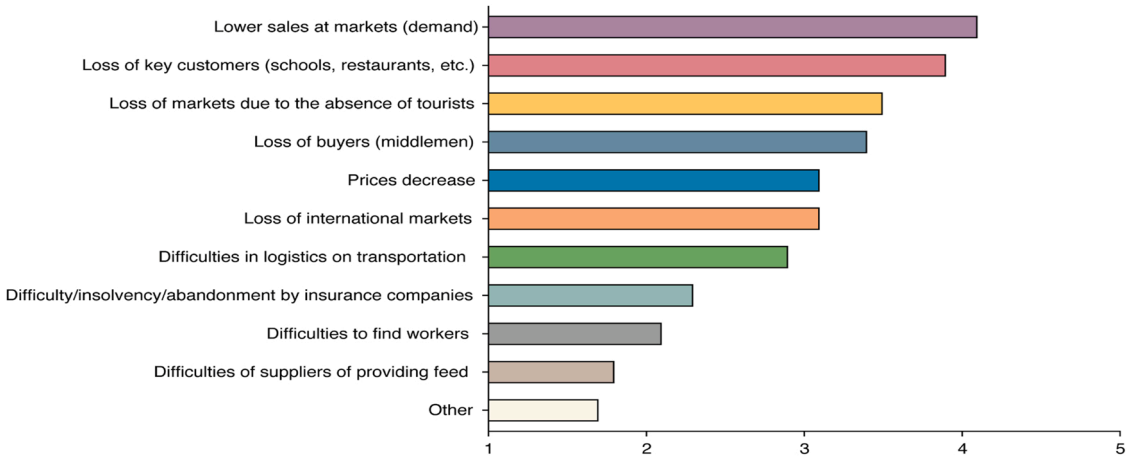

Fig. 5. Socioeconomic impacts suffered by the aquaculture activity due to the COVID-19 pandemic.
Author's elaboration based on survey results. X-axis goes from 1 to 5 where 1 is "not important'' to 5 meaning "very important".

The marine segment shows the smallest decreases of the three segments, in terms of the negative impact on sales volume and prices also leading to a less negative turnover and income compared to the other segments. The marine segments are known to consist of larger enterprises producing mainly salmon, seabass and seabream [19]. The enterprises harvest relatively high volumes of fish that mostly are aimed for supermarket chains on fixed contracts, and have larger capacity to serve different supply chains [38]. Therefore, this segment seems less affected by the crises. The impact from increasing costs is relatively low, which may be an indication that the larger enterprises have better opportunities to manage market fluctuations within the setting of the enterprise.

The magnitude of the impacts on the freshwater sector is in the middle of the other two segments when it comes to sales volume, which may reflect that the freshwater farms are able to postpone harvest until they can sell the fish. On the other hand, income parameters of the freshwater sector have almost the same impact as shellfish, which may reflect that in both cases most farmers are relatively small [39] and depend on smaller distribution channels and also local markets and restaurants for selling their product [19]. The drop in prices appears bigger than for shellfish and marine farmers, which may be an effect from depending on local market channels in a situation where supply increases compared to demand. It also seems more expensive for the freshwater farms to maintain production or postpone production; because they have to feed the fish (mostly trout). Furthermore, the relatively small enterprises within the freshwater sector [19] also have limited opportunities to manage market fluctuations within their business settings.

In Fig. 5, the respondents have listed what they think have been the most important issues influencing the aquaculture sector sales negatively. The respondents have ranked the issues going from 1 indicating "not important" to 5 meaning "very important". The following five reasons were listed as the most important by the PO's and enterprises to explain the economic impacts of the Covid-19. At the top of the list lower sales at markets due to the lower demand especially from hotels and restaurants is considered the most important issue. Secondly, the loss of key customers such as schools or traditional food markets is also relevant, whereas the loss of markets due to the absence of tourists takes third place. Fourth, the loss of international markets and the loss of buyers (middlemen) also play an important role. Finally, all these disruptions due to the effects from the lockdown and the close of commercialization channels have led to a general price decrease for aquaculture products.

Financial markets have also been severely shocked as a result of the effects of the reduction in productivity on companies' revenues and the increasing uncertainty. On March 13th, the European Commission approved the € 37 billion euro Coronavirus Response Investment Initiative (CRII) to provide small businesses and the health care sector with liquidity. On April 2nd, 2020 the European Commission launched the SURE initiative [40], with a budget of €100 billion euro in the form of loans at favorable terms to support national public expenditure in developing schemes implemented for maintaining employment and workers' incomes. In particular, the initiative supports the fisheries and aquaculture sectors to overcome the financial challenges caused by the temporary cessation of fishing activities and suspension or reduction of post-harvest production activities [41,42]. In order to support the aquaculture sector in the EU different measures have been applied in the different countries. One possibility has been to give farmers financial support through the EMFF. In Fig. 6, it is shown which respondents in which countries have received this kind of support.

5. Empirical evidence

Data of aquaculture production that covers the period of the pandemic is gradually becoming available. In this section, data for production volumes and prices are presented for Spain and Denmark for the period 2016–2020 to investigate if any effect of the Covid-19 pandemic can be detected in the 2020 data. This is done to try to validate the rapid assessment derived from the survey results for some representative EU Member States where data has been made publicly available.

The main species produced within the marine sector in the EU are seabass and seabream, where Spain is the second largest producer after Greece (after the UK leaving the EU, salmon is no longer a major species produced within the EU). In Fig. 7, the volume of production and prices for seabass and seabream in Spain are shown for the period 2016–2020. Seabream and seabass production in the EU has followed an increasing trend since 2012, with seabass being the main species produced [43]. In the case of Spain, it is usual that when the production of one of the two species increases, the other decreases, since they are produced by the same companies, which usually decide to seed more or less fingerlings of one species, depending on market price expectations in the medium term. In the long term, while the seabass produced in Spain has continued to grow, the production of seabream has followed a downward trend until 2019 in which production was half that of seabass. In 2020 there was a drop in the production of both species, that for seabream was about 50%. The explanation for this decrease is that a storm hit the producers in the beginning of 2020, which caused escapees, mortality increase and physical damage to production structures leading to production and economic losses. The decision to produce is already

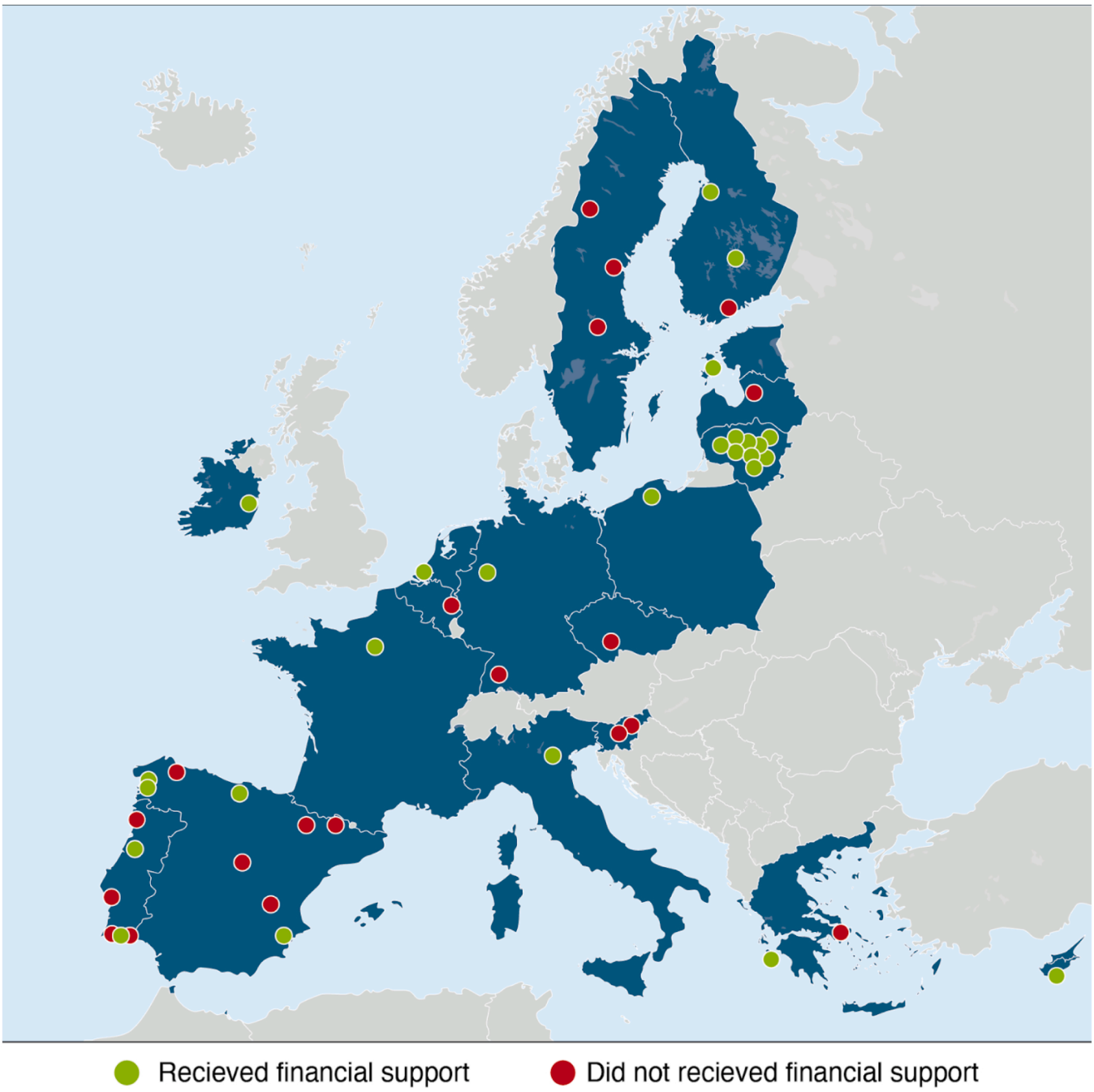

Fig. 6. Distribution of financial support to the EU aquaculture sector to deal with the COVID-19 pandemic on January 2021. Author's elaboration.

taken in 2018/2019 and the decrease is therefore most likely not a consequence of Covid-19.

The evolution of the seabream and seabass markets in Spain seems to support the argument that Covid-19 has not been the cause of the drop in production in 2020. In 2020, there was an increase in household consumption of both species in Spain of more than 20% [44]. Despite the fall in extra-domestic consumption, the estimated consumption in the Spanish market grew in both species during 2020, 6% in seabream and 1% in seabass, respectively, according to producers estimations [45]. In spite of the drop in domestic production, the increase in demand was met with an increase in imports, which may partly explain the stability in prices. The prices on the two species have been stable over the past 5 years. Although ex-farm prices remained stable, slight increases were observed in the final price paid by consumers in retail. As the markets for seabass and seabream are highly integrated at the producer and trade level [46,47], this suggests limited price effects also for producers in other EU-countries as well as Turkey.

Spain also produces bluefin tuna and turbot, which are high value species. In Fig. 8, the development in volume and prices for the two species are shown. The production of bluefin tuna has increased 50% over the last 5 years, whereas the production of turbot has been stable around 8 thousand tons. The price for bluefin tuna has been stable, even though volumes produced have increased. The price for turbot decreased 16% from 2019 to 2020. The explanation for this may be that Spanish farmed turbot is marketed through various channels, but essentially through restaurants and hotels as a premium product. This is why, although the consumption of domestic turbot grew by 50% during 2020 [44], turbot producers have had difficulties in marketing their

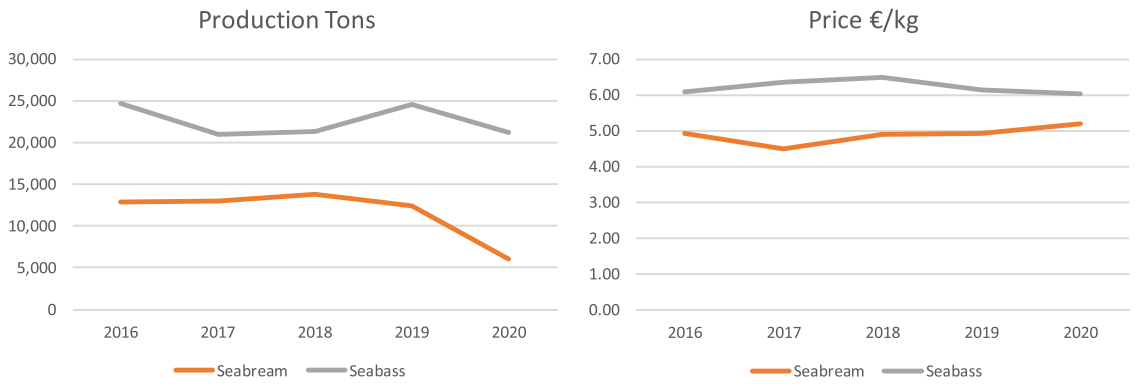

Fig. 7. Seabream and seabass production volume and price in Spain 2016–2020. MAPAMA [36].

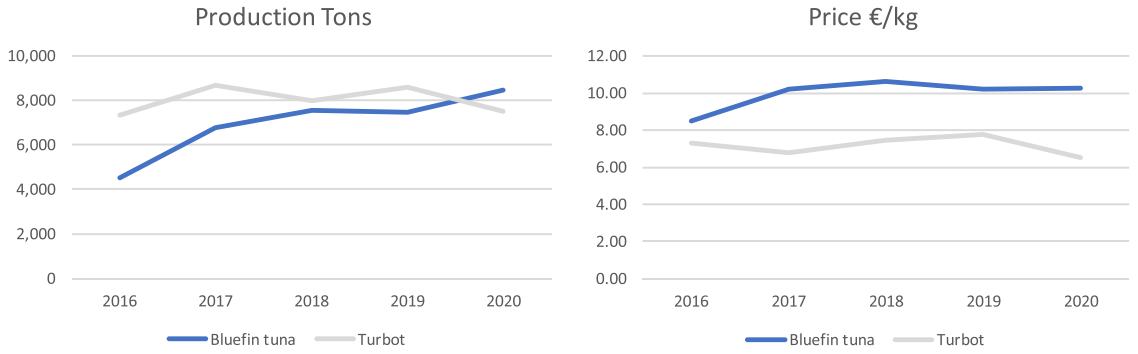

Fig. 8. Bluefin tuna and turbot production volume and price in Spain 2016–2020. MAPAMA [36].

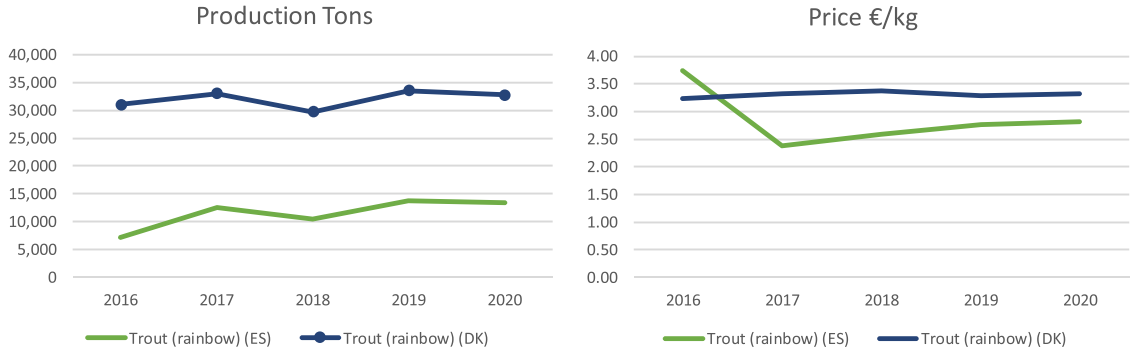

Fig. 9. Trout production volume and price in Denmark and Spain 2016–2020. Danish directorate of fisheries, aquaculture statistics and MAPAMA [36].

product as restaurants have been closed under the lockdown. Part of the fish that could not be sold fresh during the lockdown was frozen instead, and then exported. Furthermore, turbot producers shifted their sales towards the retail sector, where a significant part of turbot production is still marketed also after the restaurants and tourism recovered [37]. Thus, the price may have been affected even though other outlets have been found.

In the EU, the freshwater aquaculture sector is dominated by two species trout and carp. Trout is the most important in terms of volume and value and the most traded of the two. Denmark is the second and Spain is the fourth largest producer of trout.

The main species produced in Denmark is rainbow trout, with a production between 30 and 34 thousand tons over the period 2016–20. The numbers in Fig. 9 contain both small rainbow trout produced in freshwater and larger rainbow trout, which spend 6 month in sea cages before slaughter. For the small trout (300–350 g), the main product is smoked filet sold in supermarkets. For the larger trout (3–4 kg), the main product is whole frozen destined for supermarkets.

Rainbow trout is also the main freshwater aquaculture species in Spain. Its production is distributed practically throughout all the regions of the country. The trout consumed in Spain is mainly fresh, small and whole. Trout production, its price and its consumption have remained relatively stable in 2020 compared to 2019.

For both Denmark and Spain the production volume and price have been stable from 2017 to 2020. The slight difference in price between Denmark and Spain can be explained by the larger trouts included in the Danish numbers.

Thus, looking at the volume and price data an effect of the pandemic is not present in these data.

The EU shellfish production is mainly composed of several species of

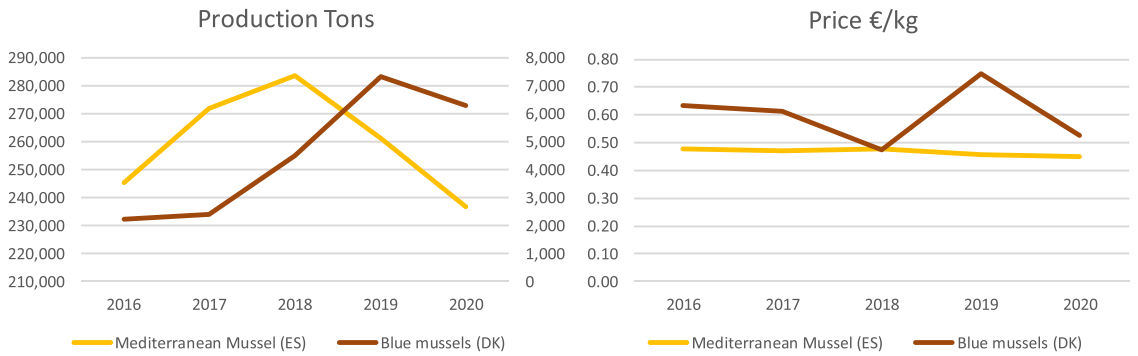

Fig. 10. Mediterranean mussels from Spain (left axis) and Blue mussels from Denmark (right axis) production volume and price, 2016–2020. Danish directorate of fisheries, aquaculture statistics and [36].

mussels, oysters and clams. Fig. 10, shows the development in volume and prices for Mediterranean mussels produced in Spain and blue mussels produced in Denmark.

Spain is by far the largest producer of Mediterranean mussels. Production takes place in rafts and it is concentrated in the region of Galicia. Mussel production has two main destinations, marketed fresh for final consumers through supermarkets and restaurants, and as a raw material for the canning industry, also located in the same areas in Galicia. The production volume peaked in 2018 and has since declined to the same level as in 2016. One of the main reasons for the decrease in production in 2019 was the higher incidence of red tides, and the closure of the mussel rafts areas during more days. In 2020, in addition to red tide episodes, the reduction in production was also related to the closure of restaurants and the decrease in exports to countries such as France and Italy. On the other hand, the price has remained constant over the period.

Denmark produces blue mussels on long lines for consumption. The mussels are primarily sold fresh in supermarkets or to restaurants. Fig. 10 shows a slight decrease in volume and price between 2019 and 2020. However, looking at a longer perspective, the volume is higher than what was produced between 2016 and 2018 and the price is higher than at the end 2018. Thus, the fluctuation in price and volume may be explained by other factors than Covid-19.

6. Discussion and concluding remarks

There is a rapidly growing literature on the impacts of Covid-19 and the associated preventive measures on seafood producers and markets. While early papers tended to focus on challenges, it is gradually becoming clear that the impacts are highly heterogeneous and were more intense during the first lockdown [48]. This paper investigates impacts for the EU aquaculture sector with two approaches; a survey and data from the two key EU aquaculture countries where production data for 2020 is now available.

The surveys' results indicate that, on average, the impact of Covid-19 is negative on the income side, increasing cost and therefore negative with respect to profit. However, there are significant variations between the respondents, and for a number of respondents the effects are the opposite, that is income and profits increase and cost goes down. There is also a high correlation between the categories where the impacts are strongest and weakest. This suggests that what is a challenge for some firms or sectors to a large extent is an opportunity for others. It is also interesting to note that the representatives for industry organizations, the POs, indicate the largest impacts. This may not be too surprising given that they would have been expected to obtain public support for the industries.

The production data for Denmark and Spain indicates moderate to no impacts of the Covid-19. The strongest impacts appear on the turbot prices, a species highly dependent on higher end restaurants. The lower price is a clear indication that there was a significant opportunity cost associated with getting access to other supply chains, particularly as the quantity was also moderately down. Bluefin tuna was doing well with both quantity and price slightly up, indicating that the supply chain challenges were not a high-value species issue. The largest species, trout, seabass and seabream all seem to have been relatively unaffected by the pandemic. In total, these data suggest that the mixed impacts suggested by the interviews are true, and if anything, that the interviews may give a slightly more negative picture than actual data for those sectors where data are available.

Overall, it seems clear that there are individual supply chains and firms, and possibly industries that were experiencing significant negative impacts of Covid-19, but that in aggregate this was mostly made up by other supply chains and firms who experienced new opportunities. The fact that there were no or only moderate quantity and price impacts for the sectors where we have data suggests that in total the EU aquaculture industry and the markets it serves have shown themselves highly resilient through the first stage of the pandemic. It will be necessary to wait to be able to observe how the European aquaculture industry reacts to other possible long-term impacts in the context of different challenges. At macro level, the increase in inflation or the rise in interest rates, and industry specific aspects such as the decrease in investment and renewal of assets in those aquaculture companies was negatively affected by Covid-19 during 2020.

Data Availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2022.105361.

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