Growth and competitiveness in the aquaculture value chain – case studies from the EU and the UK

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by

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Declaration

I hereby declare that this thesis has been composed entirely by myself. The work presented in this thesis has not previously been submitted for any other degree or qualification. The nature and extent of my work carried out by, or in conjunction with others, has been specifically acknowledged by reference.

Dimitar Taskov

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Abstract

The European Commission considers aquaculture a strategic industry and provides guidance and financial support to Member States to increase production. However, despite that, targets have not been achieved, not least due to low competitiveness against imports from third countries.

The aim of this thesis was to assist with sectoral strategy development and coordination across member states, as well as with firm-level competitive strategy formulation by, first, developing a prototype dynamic benchmarking platform of competitiveness indicators, based on adding value to publicly available quantitative data from multiple sources and covering the most important commercial aquaculture species in the EU. By analysing the heterogeneity in performance between sectors and countries, it provides insight on how to achieve a more nuanced and targeted approach to the development of aquaculture policy.

Second, using mixed-methods case study approach, the research investigates the determinants of competitive success and growth at the industry, company and product level. The findings suggest that differences in performance, are primarily the outcome of variability in the production systems used and linked natural resources, in turn leading to differences in intrinsic product attributes subject to different demand characteristics. Understanding the potential that natural resources hold across the EU that have for producing products that can enter markets with high demand, needs to be a key element of coordination and targeting.

In light of the expected change in industry structure associated with growing industries and the need for companies to adapt their competitive strategies to remain profitable, the research examines the challenges and opportunities to SMEs in a mature industry by looking at company-level case studies from the salmonid value chain in the UK. The results have pointed to concentration of bargaining power in farming and retail as a result of consolidation in those industries, as the main sources of pressure on the profitability of SMEs and the need for successful differentiation from commodity products in order to stay competitive.

Finally, the factors underlying the outcome of product-level innovation are investigated by comparing case studies of new product launches by seafood companies across the EU, where the findings point to market orientation as an important element of successful projects. However, the overall analysis has also indicated that the key policy of all-encompassing growth in aquaculture needs to be reconsidered and priorities established according to the diversity of growth potential between industries. Where growth is not likely, focus on differentiation and value addition might be more applicable.

List of Abbreviations

ASFIS	List of Species for Fishery Statistics Purposes
CF	Conversion factor
CFP	Common Fisheries Policy
CN	The Combined Nomenclature (EU international trade statistics)
EC	European Commission
EEA	European Economic Area
EFF	European Fisheries Fund
EMFF	European Maritime and Fisheries Fund
EU	European Union
EUCU	European Union Customs Union
EUMOFA	European Union Market Observatory for Fisheries and Aquaculture
EU28	The European Union composed of 28 member states
FIFG	Financial Instrument for Fisheries Guidance
FTE	Full-time equivalent (jobs)
GVA	Gross Value Added
LWE	Live weight equivalent
MAB	Maximum allowable biomass
MSFD	Marine Strategy Framework Directive
HS	Harmonised System (UN international trade statistics)
MCS	Main Commercial Species (classification by EUMOFA)
OECD	The organisation for Economic Co-operation and Development
OMC	Open method of coordination
WEF	The World Economic Forum
WFD	Water Framework Directive

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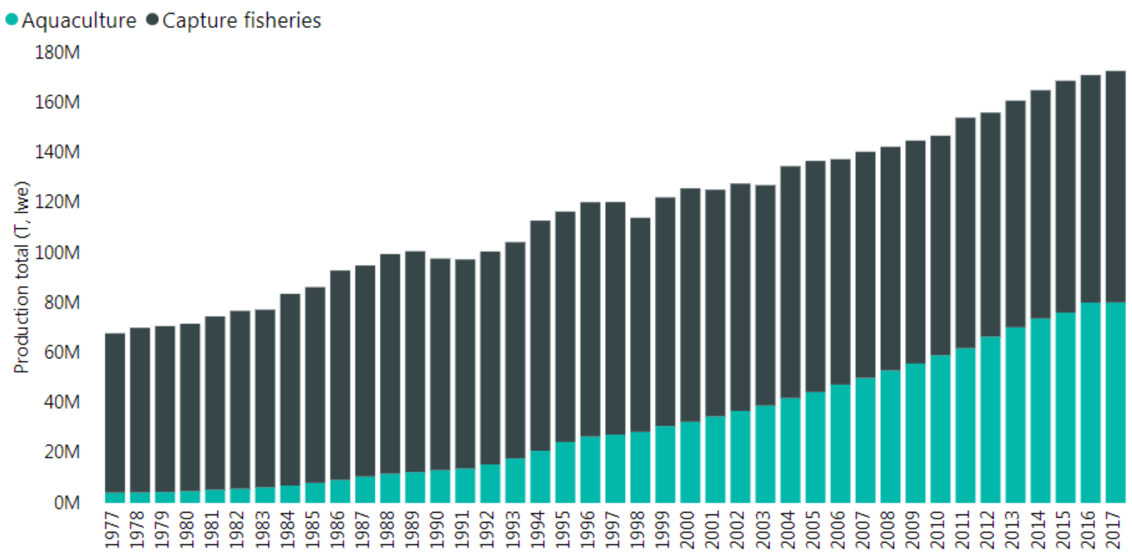
Chapter 1: Introduction

Fisheries and aquaculture are important sources of food and income globally. In the period between 1960 and 2015 the global consumption of aquatic food has been growing at a rate of 3.2% per year and the average apparent per capita consumption has increased from about 9 kg per year to 20.2 kg, outpacing human population growth. The protein in human nutrition derived from fish, crustaceans and molluscs accounted for 17% of the total animal protein intake at the end of this period (FAO, 2018b).

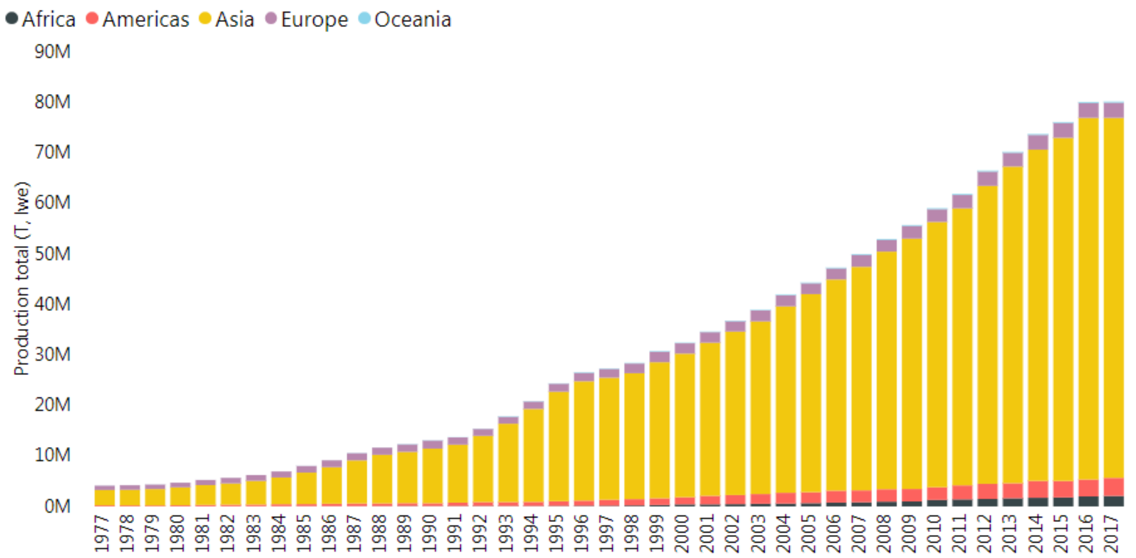
After rapid growth in marine and inland capture fisheries during the 1950s and 1960s, world fisheries output has levelled off in most of the world's fishing areas (Figure 1-1). Most wild stocks have reached their maximum sustainable yield or are being overexploited. Thus, it is not expected that substantial increases in total catch will be gained from capture fisheries in the future. In contrast, world aquaculture production (excluding aquatic plants) has grown from an insignificant amount in 1960 to more than 80 million MT in 2017, when it represented around 46% of the total supply of fish, crustaceans and molluscs. Aquaculture has been the main driver behind the increase in aquatic food availability and consumption. While its growth rate has decreased over the last two decades, aquaculture remains one of the fastest growing food production sectors (Edwards *et al.*, 2019).



Excluding aquatic plants. Source: FAO (2019)

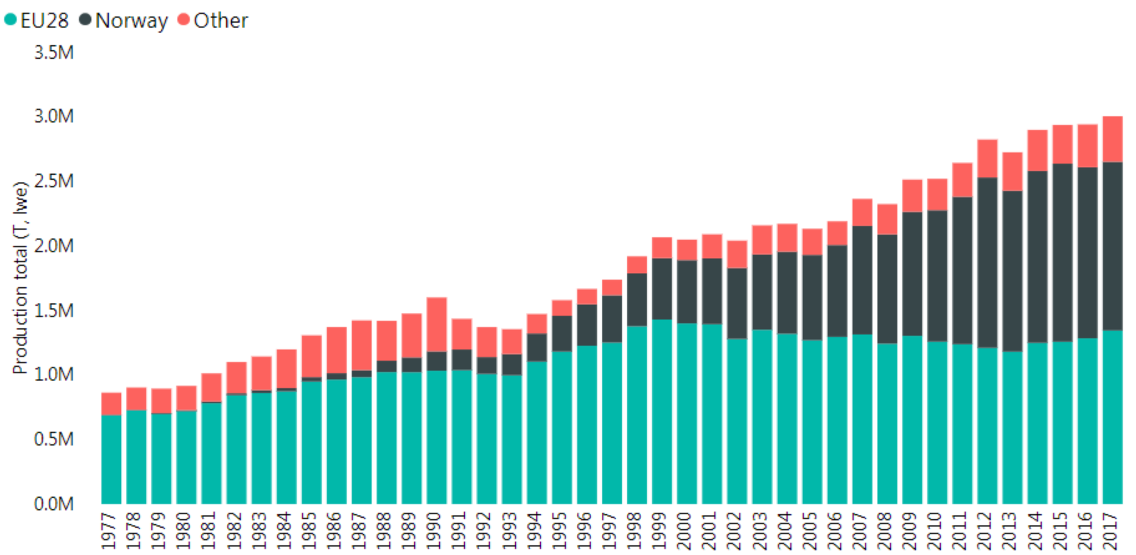
Figure 1-1. Aquaculture and fisheries production for the period 1977-2017

The global growth in aquaculture output, however, conceals a very uneven geographical distribution of production with the Asia region alone by far accounting for most of the current output and output growth (Figure 1-2). In Europe and the EU in particular, aquaculture output has been relatively stagnant over the last two decades, with some notable exceptions such as Norway (Figure 1-3).



Excluding aquatic plants. Source: FAO (2019)

Figure 1-2. Aquaculture production by region for the period 1977-2017



Excluding aquatic plants. Source: FAO (2019)

Figure 1-3. Aquaculture production in the EU (28) and rest of Europe for the period 1977-2017

At the same time, the EU is the world's largest seafood market by value (EUMOFA, 2019c). In 2017, the EU showed the highest nominal expenditure in fish among OECD countries USD 61,148 million and in terms of per capita consumption ranked after Iceland, Japan and Korea with USD 119 per year (OECD, 2020). However, demand is met predominantly by imports from third countries, resulting in a significant negative balance of trade in seafood. EUMOFA (2019c) estimates that the seafood self-sufficiency rate of the EU is below 50%. Reducing this trade gap, and the economic growth that can result from an expansion in the aquaculture industry, including in less developed regions, were the primary reasons behind a number of policies targeting the sustainable growth in the output of the EU aquaculture industry (measured in volume), issued by the EC in the period after 2000 (European Commission, 2009b). The Common Fisheries Policy (CFP) stipulated (in Article 2) the general objective to enhance the sustainability, growth, employment and level-playing field linked to the aquaculture sector (European Parliament, 2013). Aquaculture is also seen as a means to reaching the UN's Sustainable Development Goals (FAO, 2018a).

Between 2002 and 2013 the EC published three communications containing broad strategies for aquaculture expansion. The first communication, published in 2002 and titled '*A strategy for the sustainable development of European aquaculture*' (European Commission, 2002), had as main objectives (i) increasing aquaculture production by 4% per year associated with the creation of between 8,000 to 10,000 new full-time job equivalents over the period 2003-2008; (ii) availability to consumers of high quality, healthy and safe products, as well as high animal welfare standards; (iii) ensuring environmentally sound industry. While some progress was made by the end of the period, in terms of ensuring quality and safe products and environmental sustainability, the main problem – the lack of growth in production volume – was not solved, neither were the targets for new jobs met (European Parliament, 2019).

In 2009 '*A new impetus for the Strategy for the Sustainable Development of European Aquaculture*' was published (European Commission, 2009a), which aimed to identify and address the causes of stagnation, and as its predecessor, aimed to ensure that the EU is a key player in a strategic industry. By that time, in addition to the traditional challenges to EU aquaculture growth, the competition from third countries had increased and the EU was faced with the post-financial crisis reality where the short-term economic outlook was not promising and unemployment was predicted to remain high (European Commission, 2017). Thus, a strong driver for the support of aquaculture growth in this phase was job creation which was estimated to be around 3000-4000 full-time jobs for every percentage point growth in the quantity output of the industry (European Commission, 2013b). While it did not specify quantitative targets, the strategy advised implementing the following broad areas of action as a means to growth and employment: (i) promoting the competitiveness of EU aquaculture, (ii) establishing the conditions for sustainable growth of aquaculture, (iii) improving the sector's image and governance.

In parallel, the reformed Common Fisheries Policy (CFP) agreed in 2013, also aimed to make the fishing sector more sustainable and boost the aquaculture sector (European Parliament, 2013). Accordingly, an agenda for the development of aquaculture was set in 2013 with the publication of strategic guidelines to member states containing four main elements (1) administrative simplification, (2) improving access to space and water, (3) increasing competitiveness and (4) exploiting the sustainable practices of EU aquaculture and high quality products (European Commission, 2013b). According to this policy, member states define their own '*Multi-annual National Strategic Plans'* (MNSP) according to the Commission's Strategic Guidelines (European Commission, 2013b). The MNSPs were also used as the basis for negotiations between the Commission and member states leading to the final adoption of Operational Programmes and the associated funding (European Court of Auditors, 2014). The combined targeted increase in aquaculture production volume set in the MNSP of member states, was over 300,000 tonnes by 2020 (or 25% over the 2013 figure of 1.17 million tonnes) to a total of more than 1.5 million tonnes (European Commission, 2016). However, by 2018 the total aquaculture production of the EU had reached 1.3 million tonnes (or an increase of 13%).

The aquaculture growth policies have been supported by a number of funding instruments in the last three decades. The Financial Instrument for Fisheries Guidance (FIFG) was in operation between 1994 and 2006 but aquaculture was targeted more explicitly in the second half of this period (European Commission, 1999). The contribution of the FIGF to aquaculture was €567 million throughout the period (Guillen *et al*., 2019). From 2007 to 2014 the funding for EU aquaculture was continued through the European Fisheries Fund (EFF) which contributed a total of €5.57 billion over fisheries and aquaculture. The focus of the EFF was the sustainability (environmental, social and economic) objectives of the CFP (European Commission, 2006). Further, in the period 2014-2020, the financial support for aquaculture, delivered through the successor European Maritime and Fisheries Fund (EMFF), amounted to €1.725 billion (Guillen *et al.*, 2019). One of the main objectives of this budget was to "enhance the competitiveness and viability of aquaculture enterprises, including the improvement of safety and working conditions, in particular of small and medium-sized enterprises (SMEs)" (European Parliament, 2020), in addition to technological and human capital development, environmental protection and restoration. Other EU funding instruments such as the EU's Seventh Framework Programme for Research and Development, Horizon 2020, Life+ and the European Regional and

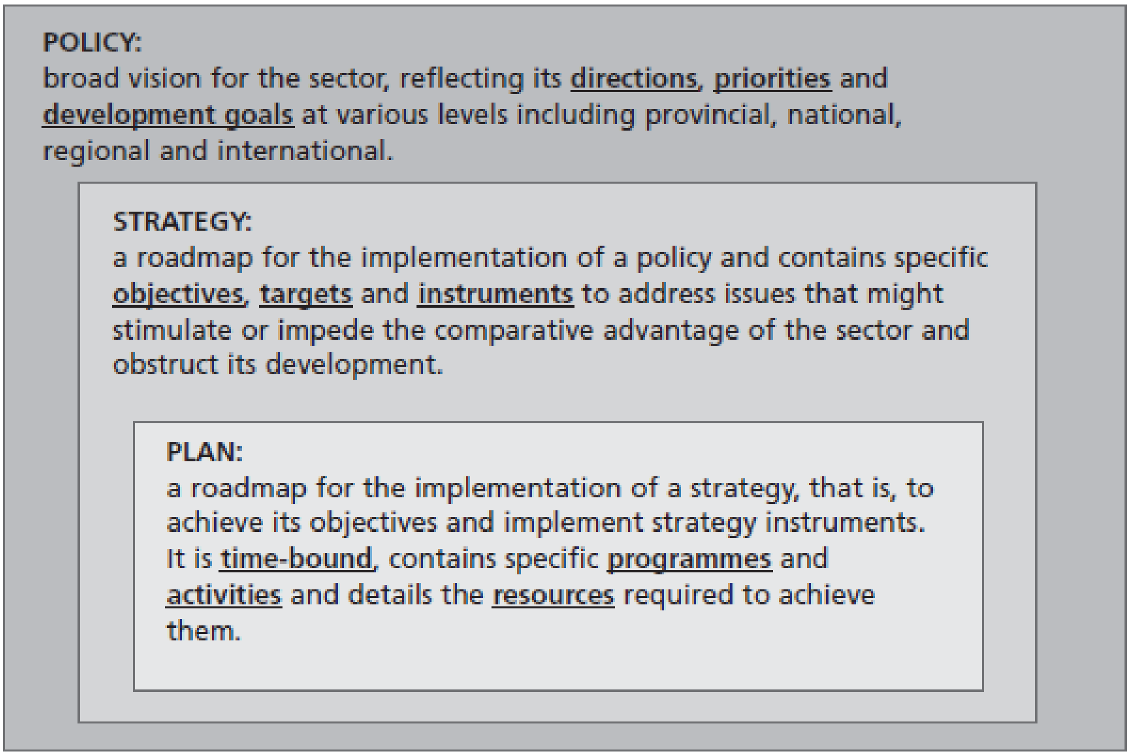
Development Fund have also been aimed at supporting financially the development of sustainable aquaculture in the EU (European Commission, 2020b).

According to Guillen et al. (2019) over the last two decades, the EU has invested a total of nearly €3 billion in the form of subsidies to aquaculture. While the targeted growth of 25% in the total output of aquaculture by 2020 by volume, as outlined in the Blue Growth Strategy (for marine and maritime sectors; 2012) was not achieved, aquaculture output grew by 40% in value over the same period while the average gross value added (GVA) increased by 71% in real terms. This growth has come mainly from increases in the production of Atlantic salmon and sea bass and sea bream at the EU periphery, mostly by large vertically integrated companies (Guillen *et al*., 2019).

The reasons for the lack of growth in aquaculture output quantity have been analysed by Bronnmann et al., (2016), Hedley and Huntington (2009) among others, and there is strong agreement that they have to do with the incompatible policies for environmental protection and economic growth, termed by Nadarajah and Flaaten (2017) the "aquaculture paradox", the fragmented and mostly small-scale nature of aquaculture industry in the EU (Guillen and Carvalho, 2016; Nielsen, Asche and Nielsen, 2016), and the linked issues of weak competitiveness in the context of strong competition from imports for many of the main commercial species produced in the EU (European Commission, 2013b). In 2016 almost 90% of the enterprises in the aquaculture sector were micro-enterprises, employing less than 10 employees with a total number of employees estimated to be 75,300 (Scientific Technical and Economic Committee for Fisheries (STECF), 2018)

Growth in the output of an industry in the context of market economy and free trade, is the result of a having a competitive product (Krugman, Obstfeld and Melitz, 2015). Competitiveness, however, is a concept that does not have a formal definition in economic theory (Feurer and Chaharbaghi, 1994; Latruffe, 2010). Instead, the variety of definitions reflects application of the concept to different entities and different scales, such as individuals, products, firms, industries, regions, nations. Porter (1990) argues that the competitiveness is ultimately expressed at the product level and the competitiveness of an industry is an aggregate of the competitiveness of the individual enterprises that form it. The competitive performance of companies is, in turn, the outcome of competition strategy (or conduct) and sector-level conditions (structure), according to the Structure-Conduct-Performance (SCP) model developed by Bain (1959). Within this paradigm, structure is identified by the presence of relatively stable economic and technical conditions of an industry within which competition occurs (McWilliams and Smart, 1993; Porter, 2007), whereas conduct (or strategy) represents the choices on parameters such as price, quality, business size, marketing, research & development, contracts etc. Strategies lead to variation in performance along different dimensions including growth, profitability, technical efficiency for cost minimisation, innovation, employment, and sustainability over time (Porter, 1981). The role of the sectoral strategy, developed by governments, is to provide a suitable business environment that increase the competitive advantage of the sector and stimulates the growth and competitiveness of the companies within it (Brugère *et al.*, 2010). Therefore, the lack of competitiveness of EU aquaculture and its inability to reach the set growth objectives, can be interpreted as signs of ineffective competitive strategies at the company level, as well as at the sectoral level.

According to Brugère et al. (2010), successful aquaculture planning involves three stages: policy, strategy and plan (Figure 1-4). However, as it currently stands, there is no overall EU strategy for aquaculture, only targeted increase in total output and broad policy directions to achieving it have been formulated (European Commission, 2013b). The competence for the management of aquaculture lies largely with EU Member States.



From: Brugère et al. (2010)

Figure 1-4. Definition of role, policy, strategy and plan

Sectoral strategies are defined by members states in their Multi-annual National Strategic Plans, under an Open Method of Coordination (OMC) (European Commission, 2020b). Aquaculture growth goals in terms of volume and value must be indicated in the MNSP and where possible supported by measurable indicators (European Commission, 2013b). However, a survey of the MNSPs reveals that, while targets are defined, the plans rarely contain a 'roadmap' for achieving specific objectives, in addition to generally lacking coherent strategy (European Court of Auditors, 2014). It is important to note that the EU aquaculture industry is composed of a wide variety of species and production systems. The distribution varies within countries as well. However, there is no indication in the policy guidelines as to the production of what species should be prioritised and where should growth be focused. Most member states are targeting a wide variety of sectors and systems as a result of which, as Guillen *et al.* (2019) points out, the subsidies that are distributed at national level, end up scattered into many small-scale projects, limiting the effectiveness with which funds could be spent, and calling for the establishment of EU-level priorities for species and systems for the most effective utilisation of resources.

The OMC is the framework for national strategy development and for coordinating policies between EU Member States (European Commission, 2019). The OMC relies on voluntary cooperation between the member states and 'soft-law' mechanisms such as guidelines, best practice sharing and mutual learning, comparative indicators and benchmarking (Szyszczak, 2006). In addition to MNSPs, the tools of the OMC include technical seminars and high-level events to exchange good practices and foster a mutual learning process across the EU, i.e. improve coordination (consisting of at least one technical seminar per year organised by the Commission and attended by MS representatives), as well as the development of guidance documents on EU legislation which offer practical answers to questions about the application of EU law in relation to aquaculture e.g. regarding the Water Framework Directive (WFD) and Marine Strategy Framework Directive (MSFD) (European Commission, 2020b).

The OMC is a preferred mechanism of governance because, in the context of a voluntary union such as the EU, it responds to the tension between heteronomy (central regulation) and autonomy (local responsibility) (Arrowsmith, Sisson and Marginson, 2004). The effectiveness of the method is based on comparisons of performance and peer pressure rather than on top-down regulation and official sanctions. Benchmarking has become a key instrument of the OMC (Arrowsmith, Sisson and Marginson, 2004). Benchmarking is a process of identifying examples of outstanding performance and adapting practices that can match this performance. It assumes that in any field, some units (companies, industries) perform better than others. These best-in-class performers set a ‘benchmark’, a standard of excellence, against which to measure and compare (Jarrar and Zairi, 2001). Since benchmarking is the main coordination mechanism for achieving the EU-wide aquaculture policies, its effective implementation is vital. The importance of coordination is highlighted by the European Commission (2009b): “The Commission believes that a strong, reinvigorated aquaculture industry would serve as a catalyst for growth in related sectors and further contribute to the development of rural and coastal areas. Moreover, consumers would benefit in the form of healthy, high-quality food products produced in an environmentally friendly way. These are just some of the crucial benefits that would accrue from concerted European action at all levels to unlock the aquaculture sector's full potential.”

Concerted action requires that comparable data exist across MSs, based on which indicators are developed, in line with the policy objectives, to serve as the tools for coordination, comparison and monitoring of change. There are several sources of data with regards to the aquaculture objectives of the EU, and periodical publications which compare performance across countries, which are examined in more detail in Chapter 3, however, there is no systematic tool or a platform that serves this objective. The lack of common OMC indicators and quantified targets as well as a common monitoring system have been listed as key limitations for the evaluation of the effectiveness of the OMC (European Commission, 2020b).

Considering this context, the first objective of this thesis is:

1. How can improved, accessible decision support tools can be developed from existing data to aid the competitive strategy development process of Member States?

The aim of this question was to investigate the possibilities for using the large amount of publicly available and regularly updated data on the sectoral conditions of aquaculture and add value to them by developing usable and easily accessible benchmarking tools that can aid sectoral strategy development and coordination between MSs, as a form of evidence-based strategic decision-making. An effective benchmarking tool would be able to ‘contextualise’ the state of the ‘national situation’ with respect to the other member states and suggest priorities for the national industry in the context of other member states to achieve some level of specialisation, which takes advantage of the unique resource endowment or the state. This can serve as a basis for coordination and negotiation between member states in the context of OMC, as to establish priorities for each MS, to increase the efficiency of resource use and increase the likelihood of achieving the common objective.

However, a fundamental criticism of performance benchmarking is that it rarely transforms into strategy. For this to occur it is not sufficient to know simply what the differences between the compared units are, but the reasons behind those differences. By focusing on the 'numbers', the latter step can easily be omitted which results in benchmarking becoming an 'audit' instead of a tool for learning and improvement (Arrowsmith, Sisson and Marginson, 2004). Therefore, the inquiry continued with an explanatory part whose overall goal was to shed light on the reasons behind the performance differences, and lead to strategic insight, while also 'testing' the benchmarking platform in real-life situations and suggesting ways in which it can be improved.

Recognising the multi-layered nature of competitiveness, the exploratory part covered the level of the industry, firm and product. At the industry level, one of the first attempts to explain why some industries grow and other do not in the context of international trade, was the theory of absolute advantage, which states that a country benefits from producing goods and services in which it has an absolute cost advantage over other countries and imports those goods and services in which it has an absolute cost disadvantage (Krugman, Obstfeld and Melitz, 2015). This theory of specialisation, however, could not explain why a country which has an absolute advantage in all products would still import. This led to the advancement of Ricardo's law of comparative advantage stating that a country must specialise in those products that it can produce relatively more efficiently than other countries (Krugman, 1994). In other word, a country can still export those goods and services, despite absolute cost disadvantages in the production, as long as the absolute disadvantages are the smallest and imports products with the largest absolute disadvantage. However, the theory of comparative advantage does not explain the location of these advantage. The Heckscher–Ohlin model (H–O model), one of the most influential economic models which, which builds on the law of comparative advantage, poses that countries differ with respect to their factor intensities, namely the labour and capital that are used in the production of goods and services (Henriques, 1994). The factors, which determine factor intensities are many and have been the subject of extensive research over the years, however they have been summarised by Porter (1990) in an easy to understand and applicable theoretical model (Smit, 2010).

Porter (1990) links the competitiveness of an industry to the conditions in the 'proximate environment' in which the industry is located. The theory, commonly referred as Porter's Diamond framework, aimed to explain why nations succeed in some industries and not in others. The primary conditions which he identified were factor conditions, demand conditions, related and supporting industries and firm structure and rivalry. These are interrelated and dynamically interact with each other to create conditions for ‘upgrading’ of comparative advantage. Factor conditions refer to resources, whether physical, human, knowledge, capital or infrastructure, which an industry requires for its operations. Thus, factor conditions are not merely inherited (e.g. natural resources) but can be intentionally created (e.g. training, infrastructure etc). Porter distinguished between basic production factors (such as natural resource endowment) and advanced factors, which are specialised for an industry and are usually developed through the process of ‘upgrading’. It is the latter group which brings sustainable competitive advantage. In addition to factor conditions, sophisticated demand conditions on the domestic market, can create opportunities for an industry to achieve competitive advantage abroad, by stimulating faster innovation than competitors and the creation of more advanced products. Also, Porter recognised that industries do not become internationally competitive in isolation but rather within clusters of related industries (which require similar inputs but whose outputs are not competing directly with each other) and supporting industries who provide the inputs to or process the outputs of an industry. Importantly, the level and structure of rivalry in the industry and the ways in which firms address competitive challenges (i.e. strategy) plays a crucial role in the international competitiveness of the industry. Intense competition at home creates opportunities for innovation and developing a competitive edge abroad. In addition to these factors, government interventions, whether at local or national level, can affect each of the above factors e.g. limit the supply of production factors, influence demand conditions, regulate competition, while events not within the control of the firm (chance) can create ‘game changing’ opportunities for some industries to gain competitive advantage and other to lose it. Modifications to the framework have been proposed by a number of academics, notably The Double Diamond theory which also accounts for the factor conditions of the trading partner (Moon, Rugman and Verbeke, 1998). The concept of rivalry between nations (suggested by the title of the book) has been questioned by the influential economist and proponent of free trade Paul Krugman (Krugman, 1994). Dunning (1993) has re-defined the notion of a home base to mean all countries in which economies are linked to each other, and not merely the nation in which a company is situated.

In trying to understand why in aquaculture some industries grow while other do not, the second objective of this research was:

2. What sectoral-level factors determine the growth potential and competitiveness of an aquaculture industry?

Competitiveness at the company level, as well as the product level, would translate to being able to make sales that meet certain demand requirements more successfully than rivals and still make a profit (Janger *et al.*, 2018). In market structures other than monopoly, profitability is an important measure of competitiveness. Thus, one of the most widely adopted definitions of competitiveness at the firm level is the ability of a company to maintain its competitive advantage and increase its profitability over the long term (Porter, 1985). As highlighted before, competitiveness is the result of successful competitive strategy. The firm-level strategy-making process is dependent on a number of factors including the structure of the organisation (Gibbons and O'Connor, 2005), business orientation (Covin, Green and Slevin, 2006) and uncertainty (Dess, Lumpkin and Covin, 1997) and the stage of the industry life cycle (ILC) (Verreynne and Meyer, 2010).

The generic concept that entities subject to growth and competition undergo a similar dynamic pattern of development, described as a life cycle, has found application in the field of strategic management to guide managerial decisions, since every stage in the life cycle can be characterised with specific success factors requiring different managerial approaches and generic strategies (McGahan, 2000). The most well recognised model usually depicts sales volume or value against time, with distinguishable stages representing introduction, growth, maturity, and decline of a product (Levitt, 1965). However, different variations on the concept exist, for example, identifying three stages instead of four (Klepper and Graddy, 1990).

The concept of ILC can be summarised as follows (Lumpkin and Dess, 2001): industries begin with a period of fragmentation as different approaches are being tried out. The progression of an industry along a life cycle pattern has been explained by the gradual emergence of a dominant product design (Suárez and Utterback, 1995) or a dominant production system (Asche *et al.*, 2013) from an initial wide variety of designs resulting from an influx of firms into the attractive new industry and a variety of ideas. A period of shakeout follows in which firms with alternative and unaligned models are forced to exit. The dominant model allows firms to exploit economies of scale and scope, which leads to a growth in the volume of sales across the industry (Lumpkin and Dess, 2001). The firms that cannot adapt to the dominant design or production configuration gradually exit the industry, while those that remain are locked into the dominant design which eventually exhausts the opportunities for innovation and productivity growth stabilises. This also tends to be accompanied by increase in the capital-intensive production methods which raise the barriers to entry for new firms and drive out smaller rivals (Kruger, 2008). A period of decline may follow, caused by saturated demand or the emergence of a substitute and overall output and value of the industry declines (Lilja, Sundberg and Sundberg, 2015).

Thus, firm strategy varies with the industry life cycle. In the introduction and growth stages of the industry strategies that focus on innovation would be favoured, because an abundance of opportunities exists and companies tend to be proactive and innovative (Ciavarella, 2003), while strategies that favour efficiency and cost-reduction tend to be more successful in the mature stage of the industry cycle (Bos, Economidou and Sanders, 2013) where more competitors enter the market, competition intensifies and to survive firms need to take market share off their competitors (Lumpkin and Dess, 2001). That is particularly so in low-tech capital intensive commodity industries (Bush and Sinclair, 2006). Similarly, business approaches that lead to process efficiencies become the dominant model at later stages of the industry life cycle (McGahan, 2000).

Evidence suggests that as industries grow and mature, they become increasingly consolidated and concentrated into a small number of large-scale companies (Deans, Kroeger and Zeisel, 2002). While, as a whole, the EU aquaculture industry is highly fragmented and composed of a large number of small-scale businesses, there is a wide variation in industry composition across sectors and regions. Nonetheless, if substantial growth is expected in the aquaculture industry, it is likely to be accompanied with consolidation as the industry reaches maturity. That will put more pressure on the SMEs and result in the exit of many small companies from the industry. Since SMEs are usually resource-restrained (Voss *et al.*, 1998) but they represent the backbone of Europe's economy, the EU supports the existence of a dynamic and competitive SME sector (European Commission, 2020c) and SMEs are specifically mentioned as target beneficiaries in the fisheries and aquaculture structural assistance policy (European Parliament, 2020). An investigation into the competitive strategies of SMEs which successfully co-exist with large companies in already consolidated sectors in the EU can provide insight to other SMEs in similar competitive environments following a consolidation trend, leading to the third objective of the thesis:

3. What business-level strategies do successful SMEs use in a mature EU aquaculture industry?

Growth in the output of an industry, however, is not the only route to economic (GDP) growth. GDP represents the monetary value of all products and services produced in the country within a defined period of time. Gross value added (GVA) is an important component of GDP gross value added (GVA) because it measures the contribution to GDP made by an individual producer, industry or sector. GVA is the value of output minus the value of intermediate consumption (Krugman, Obstfeld and Melitz, 2015).

When it comes to value, it is important to distinguish between 'use value' and 'exchange value' where 'use value' refers to the specific qualities of the product perceived by customers in relation to their needs while exchange value is the price paid at transaction (Bowman and Ambrosini, 2000). The difference between the customer's valuation of the product, and the price paid is 'consumer surplus' (CS). It is CS that guides consumers' purchasing decisions and therefore the competitiveness of a product (Bowman and Faulkner, 1997). CS can be increased by enhancing the perceived use value of the good (and thereby increasing its total monetary value, the amount the customer would be prepared to pay for it), whilst keeping the price at the same level, or by keeping the total monetary value constant but reducing the price, or by doing both.

Consumer needs are subject to change over time, termed market turbulence and may be as a result of demographic, socio-economic, and cultural changes in society (Grunert and van Trijp, 2014). As for consumer valuation, Adner (2004) argues that it has two dynamic elements, threshold level of performance which needs to be met for the offer to be considered acceptable, and the way in which consumers value improvements above the threshold level. The threshold level itself is a function of expectations, tastes, and existing substitutes. On the other hand, consumer valuation of improvements above threshold level is characterised by initially increasing rate in marginal utility as performance increases, followed by decreasing marginal utility i.e. decelerating rate of willingness to pay (WTP) for performance improvements, which eventually reaches a plateau, which, can also be described as a life cycle and depicted by an s-curve.

New use value is created through innovation (Traill and Meulenberg, 2002). Thus, innovation is essential in creating and sustaining competitiveness, which in turn fosters overall firm and industry growth. Innovation is a 'good, service or idea that is perceived by someone as new' (Grunert *et al.*, 1997). According to the same authors, innovation may be related to invention but not all product innovations are based on inventions. New product could merely be an improved existing product. Schumpeter (1939) distinguishes between five types of innovation: introduction of new products; introduction of new methods of production; opening of new markets; development of new sources of supply for raw materials or other inputs and creation of new market structures in an industry. Similarly, The Oslo Manual on collecting and interpreting innovation data distinguishes between four innovation areas: product, process, marketing and organisation (OECD, 2005).

Depending on the stage of industry life cycle, innovation efforts would be directed at different areas of production. In the mature stage innovation tends to be oriented towards reducing costs, often by improving productivity, achieving economies of scale (Bush and Sinclair, 2006), while innovation in the design of the product will play an important role in the growth stage (Verreynne and Meyer, 2010). However, industries are linked in a value chain (Gereffi and Fernandez-Stark, 2011) in which the output of one industry becomes the input for another and value is added at every stage until the product reached the end user. Thus, opportunities for value addition exist not only the aquaculture stage of the seafood value chain, but also ‘upstream’ in aquafeed production and other supplies, as well as ‘downstream’ in seafood manufacturing. The food and drink manufacturing industry in the European Union was the largest manufacturing sector in terms of value of the output with 15% of the total manufacturing turnover. It also remains one of the largest in terms of employment and number of companies, the large majority of which are SMEs (ECSIP Consortium, 2016). Therefore, opportunities for economic growth through value creating innovation where SMEs can play an active role exist not only in the aquaculture link of the seafood value chain but in the seafood processing industry as well. However, unsuccessful innovation may be even more harmful to the firm than no innovation, given the high costs associated with it (Traill and Grunert, 1997). The commonly reported figures for new food product failure are between 70% and 90% (Stewart-Knox and Mitchell, 2003).

In view of these opportunities and threats to economic growth, the fourth and final objective of this thesis was:

4. What competitiveness factors determine the commercial success or failure of product-level innovation strategies?

Each of the questions framed in this chapter was addressed in a separate study, corresponding to one of the following four chapters (3-6) of this thesis. The next chapter details the research methods used in answering these questions, while the final (seventh) chapter discusses the implications of the findings and avenues for further research.

Chapter 2: Research methodology

A mixed-methods explanatory-sequential design (Creswell and Clark, 2011) consisting of two phases, was used as an overarching methodological framework, under which the individual studies were conducted (Figure 2-1). The role of the first phase, covering question 1 and chapter 3, was to develop a prototype platform for coordinating strategies across member states and benchmarking performance. It was also an objective to 'quantify' the competitive performance of aquaculture on an EU level and provide the competitive context for the following qualitative studies. The second phase, which concerned research questions 2 to 4 aimed to investigate the reasons behind the variation in competitive outcomes and provide suggestions how the prototype benchmarking platform can be improved by examining empirical evidence in the form of case studies. The aim was not to make generalisations about the entire region but through this to establish a pattern of inquiry, which can be replicated with other aquaculture industries and countries of the region and raise hypotheses and questions for future research.

In line with the multi-scale concept of competitiveness, these studies covered the industry, enterprise and product level, while their focus, i.e. selection of the units of analysis were informed by results of the preceding questions/ chapters, and emerging issues at the time of study. As is common in mixed methods research designs, there was iteration and feedback linkages between the first and second phase of the study. For example, the choice of industries that formed the case study analysis in Chapter 4 was based on the vast performance differences identified in chapter 3. Similarly, the research questions were refined in the course of the study as evidence was emerging from the explanatory phase. While both phases used qualitative and quantitative data in mixed methods approach, greater emphasis was placed on quantitative data and analysis in phase 1 and on qualitative analysis in phase 2.

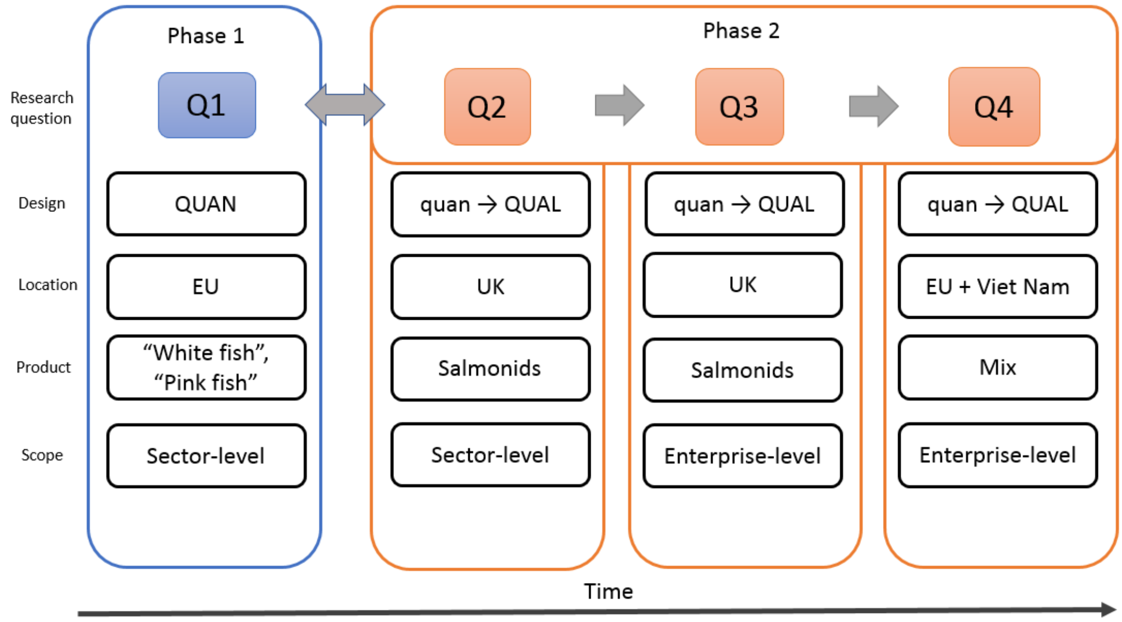


Figure 2-1. Diagram of thesis-level, mixed-methods research design

2.1 Phase 1: Development of benchmarking platform

The objectives of this study phase were two-fold. First, the study aimed to extend the scope of tools available to decision makers in aquaculture by (i) developing relevant sector-level indicators of competitiveness for evaluation and continuous monitoring of EU aquaculture performance to aid the coordination of strategies between member states in line with the ambition of the OMC; (ii) to examine the performance of selected aquaculture industries in the EU against third country competitors and to evaluate the contribution of these industries to national economies. (iii) operationalising the indicators into prescriptive analytical tools for strategy support and (iv) applying and the tools on the main EU aquaculture commodities to uncover policy implications with particular focus on opportunities and threats for different growth strategies. Secondly, by examining the EU seafood market and aquaculture production patterns, the ambition of the study was to establish the context for the set of studies that form the rest this thesis contributing to iteration of the research questions in the following study phases.

The underlying assumption of this study was that sufficient heterogeneity exists both across products on the seafood market and across member states (in their capacities as producers and consumers) to render a "one-size fits-all" policy or investment strategy approach ineffective.

The target audience of this study is policy makers and export-orientated businesses/business consultants for whom sector-level considerations play an important part in decision-making.

2.1.1 Framework

A benchmarking tool is effective when it can translate the outcomes of benchmarking into strategy (Arrowsmith, Sisson and Marginson, 2004). Researchers in strategic management agree that the SWOT analysis (strengths, weaknesses, opportunities and threats) provides the foundation for aligning variables in the external and internal environment, that helps planners to better understand how strengths can be leveraged to realize new opportunities and how weaknesses can be overcome (Porter, 1991; Johnson *et al.*, 2014). In fact, the guidelines to the development of MNSPs specify that analysis of strengths and weaknesses, needs to be part of the MNSP under the set of measures on enhancing the competitiveness of EU aquaculture (European Commission, 2013b).

Based on a survey of the literature on indicators of competitiveness (Buckley, Pass and Prescott, 1988; Latruffe, 2010; Ketels, 2016; Janger *et al.*, 2018; Gomes Ferreira *et al.*, 2020), a number of indicators relevant to the analysis of strengths, weaknesses, opportunities and threats were identified and evaluated as to whether they can be calculated using the publicly available sources of data listed in section 2.1.3. The final selection of indicators can be found in Table 2-1. The selection was not intended to be definitive but, in line with the prototype format of the platform, to establish an initial basis on which more aspects of analysis could be added with further research, as well as to test the usefulness of the selected indicators in providing insight on the potential for growth and competitiveness of the EU aquaculture industry.

Table 2-1. Rationale and calculation of ecomomic performance indicators and metrics

Metric	*Rationale/explanation*	*Calculation*
Total supply	A measure of the quantity of input of a particular category into a country or region from all sources	Total supply (T, lwe) = capture fisheries production + aquaculture production + imports
Apparent consumption	A measure of market size and proxy for demand.	Apparent consumption (T, lwe) = (aquaculture production + capture fisheries production) + Imports – Exports
Share of trade flow (imports or exports) in total supply	A measure of the extent of trade in a commodity normalised by the total input into a country	Share of trade flow in total supply (%, lwe) = Trade flow / total supply * 100
Share of regional trade flow (intra-EU or extra-EU) in total trade	A measure of the geographic scope of trade normalised by total trade	Share of regional trade flow in total trade (%, lwe) = Regional trade flow / total supply * 100
Price	A measure of unit value	Price (EUR/kg) = Value (EUR) / Net volume (kg)
Self-sufficiency	A measure of the extent to which the quantity of home production meets home demand	Self-sufficiency (%, lwe) = Production / Apparent consumption
Concentration ratio (CR_4)	A measure of market structure and in particular, the control of the four largest firms in the industry	The total market share of the four largest firms in an industry *$CR_4 = (S_1+S_2+S_3+S_4)$ / Total industry sales*
Gross value added (GVA)	An economic productivity metric that measures the contribution of a sector to the national economy. It provides a monetary value for the amount of goods and services that have been produced in a country, minus the cost of all inputs and raw materials that are directly attributable to that production.	GVA = Turnover + Other income – Energy costs – Livestock costs – Feed costs – Repair and maintenance costs – Other operational costs The calculation is based on methodology by Nielsen, Carvalho and Guillen (2018)
Unit labour cost (ULC)	A proxy for cost-competitiveness. Higher ULC for the same unit of output is a sign of lower competitive potential.	ULC = Wages and salaries / FTE
Labour productivity	Productivity is the key source of economic growth and competitiveness. It is defined as the ratio between output and input	Labour productivity (EUR /FTE/ Year) = GVA at factor costs / FTE
System productivity	The efficiency with which a production system to create economic value per unit of output	System productivity = GVA per year / Total volume output (T, lwe) per year
Net profit margin (%)	A measure of the economic performance of a sector or enterprise expressed in relative terms. It is a difference between total income and all incurred costs (operating, capital and financial)	Net profit margin (%) = (Turnover + Other Income + Subsidies – Energy costs – Wages and salaries - Imputed value of unpaid labour - Livestock costs – Feed costs – Repair and maintenance – Other Operational costs – Depreciation of capital – Financial costs, net) / (Turnover + Other Income + Subsidies) *100
Revealed comparative advantage (RCA aka Balassa Index)	A measure of specialisation in the export or import of a commodity and a proxy for comparative advantage RCA is two types: Revealed export advantage (RXA) and Revealed import advantage (RMA) A value of >1 indicates the existence of comparative advantage in the production of a commodity as inferred by export specialisation patterns, (Cai, Leung and Hishamunda, 2009)	$RX(M)A_{is} = \frac{\sum ip}{\sum is} \Big/ \frac{\sum ns}{\sum nk}$ $RXA_{ip} = \frac{\sum ip}{\sum is} \Big/ \frac{\sum mp}{\sum ms}$ Where i = Country p = Commodity (particular seafood commodity traded) s = Seafood (all seafood commodities traded) m = EU28 n = world k = all trade in merchandise
Compound annual growth rate (CAGR), %	Compound annual growth rate (CAGR), applied to the above indicators, was chosen as a measure of change because of its ability to dampen the effects of fluctuations within the examined period and thus to isolate the trend in the data (Chan, 2012)	$CARG\ (t_0, t_n) = \left(\frac{V\ (t_n)}{V\ (t_0)}\right)^{\left(\frac{1}{t_n - t_0}\right)} - 1$ where t_0 is the initial of the year, t_n is the end year, $t_n - t_0$ is the number of years in the specified period (3 in this case). Three years rolling intervals was used here because of the limited time period 2012-2017

The selected indicators were organised in two broad categories relevant to SWOT analysis – "Opportunities and threats" and "Strengths and weaknesses", the first of which focused on market-related aspects, while the latter – on production related issues. The contents of these categories were also related to the notion of demand and supply, and the strategic implication that these carry for firms in the aquaculture industry and policy makers. Measurement tools used here combine concepts from two macro and micro economic schools – neoclassical economics, focused mainly on international trade based measures centred on comparative-advantage and opportunity cost trade-offs, and the strategic management school or 'resource-based view' which favours measures based on the firms structure and strategy, including measures of cost, productivity and efficiency (Lusch, 2000; Latruffe, 2010).

The category "Opportunities and threats" included a provisional selection of benchmarking tools focusing on market size, market globalisation and market share. Market size, expressed as apparent consumption, in combination with market size growth, was used as a proxy for demand and demand growth and as such it indicates the attractiveness of the target market. From investors perspective, high growth markets present more opportunities for firm growth, however, they also require more investment (Henderson, 1973). Therefore a careful analysis of the resources of the firm needs to be performed to evaluate the potential for turning this opportunity into real gain for the firm (Barney, 2000).

Similarly, the extent of globalisation of a product showed the geographic spread of the market. Global markets can represent both opportunities and threats to the enterprises supplying them, because they tend to be dominated by commodities which on one hand, are characterise by large market size, and from that perspective can be seen as attractive to invest in, but on the other hand, prices of commodities are affected by factors beyond the immediate control of the producer e.g. by events in other producing regions of the world, thus also posing a risk, especially for small-scale producers, who tend to be more vulnerable to price fluctuations (Ravenhill, 2014; Gereffi and Fernandez-Stark, 2016).

Competitiveness at the national sector usually is positioned within the context of international trade. For example, the OECD defines competitiveness as "the ability of companies, industries, regions, nations and supranational regions to generate, while being exposed to international competition, relatively high factor income and factor employment levels on a sustainable basis" (Hatzichronoglou, 1996). At the industry level, competitiveness usually relates to the competitive strengths and weaknesses of the industry in relation to the same industry in other countries (Peneder *et al*., 2018). Thus, a competitive industry can be defined as "having sustained ability to profitably gain market share in domestic and/or foreign markets" (Leung, Lee and O'Bryen, 2007), which was the rationale behind the market share tool.

In the category "Strengths and weaknesses" provisionally were included tools focusing production aspects, namely industry concentration, self-sufficiency in seafood, and productivity. Industry structure changes with the as the industry progresses through its life cycle (Klepper, 1996). As an industry becomes more mature it tends to concentrate (Deans, Kroeger and Zeisel, 2002). To establish the extent of concentration and, thus, the level of competition, the concentration ratio CR_4 was used, which represents the extent to which the market is controlled by the four largest firms in the industry (Pepall, Richards and Norman, 2014). CR_4 is not the only measure of market structure. Another common measures of concentration is the Herfindahl-Hirschman index - HHI (Anbarci and Katzman, 2015). The advantage of the HHI over the simpler CR_4 is that it accounts for the distribution of output over the entire industry. However, this is also a limitation since the data requirements for its calculation, especially in aquaculture, are too large. For most industries it is simply not possible to obtain company-level data for all companies in the industry. The preference of the CR_4 here, over other measures CR_8 or CR_{10} (the largest eight or ten companies, respectively) was, on the one hand, data availability for a larger number of companies, but on the other hand, the wide use of CR_4 in the competitiveness literature (Pepall, Richards and Norman, 2014) and therefore, ability to compare the results with a wide variety of other industries for which this has been calculated.

Self-sufficiency in seafood production was calculated since it is an important basis for the aquaculture growth policies in the EU (European Commission, 2013b) whereas productivity is the determinant of national per capita income since the standards of living for the citizens of a country, depends on the productivity with which a nation's capital and labour are used. Thus productivity, which is the value of the output produced by a unit of labour or capital, in turn depends on both the types of products that are produced (which determines their price) and the efficiency with which they are produced. In fact, Porter (1998) argues that the only meaningful concept of competitiveness at the national level is productivity.

The organisation of the selected indicators into tools relevant to sectoral strategy, was guided by common strategic management approach, namely the two-dimensional (2D) matrix. While complex methods of data modelling and simulation exist, the use of simple tools such as the two-dimensional matrix remain common in strategic management. Two examples of this approach that have found wide application, particularly in the corporate management realm, are the BCG matrix (Henderson, 1973) and the McKinsey matrix (Dyson, 1990). The concept of the 2D framework is that the two dimensions (typically plotted as X-axis and Y-axis) do not correlate with each other, but rather represent two important aspects that the analyst needs to consider. The value of this approach lies in the ability to reduce complexity to the essence of an issue and frame it in terms of priorities and choices that can be made. An important feature of the 2D matrix is that it is typically divided into quadrants, each carrying different strategic implications. As such, it is particularly useful for distributing the units of analysis into categories and thus for developing typologies that allow more precise yet standardised and coordinated strategic action. Hence, an important feature is that the quadrants of the 2D matrix do not necessarily represent right or wrong positions. Rather, they represent options that decision-makers need to consider in line with the objectives of the analysis.

To provide more specific insight into how growth should be achieved, i.e. consistent with EU aquaculture policy objectives (Chapter 1), when discussing the implications of the results reference is often made to Ansoff's product-market matrix (Ansoff, 1957), which is one of the most widely adopted frameworks in marketing strategy (Johnson *et al.*, 2014). It defines four options for growth based on choices about products and markets, that can be represented as a two-dimensional matrix (Figure 2-2). Typically, the analysis starts by considering the existing products and markets served, from which point it proceeds to consider possibilities for increasing diversity by increasing the novelty along both axes, which results in four broad strategies to growth: 'market penetration', 'market expansion', 'product development' and 'diversification'. Increasing the level of 'newness' along either dimeson, whether in relation to the company or to the market (Grunert and van Trijp, 2014), generally correlates with higher level of risk, since the company has less experience with the new product or the market and performance estimations become more difficult (Henard and Szymanski, 2001).

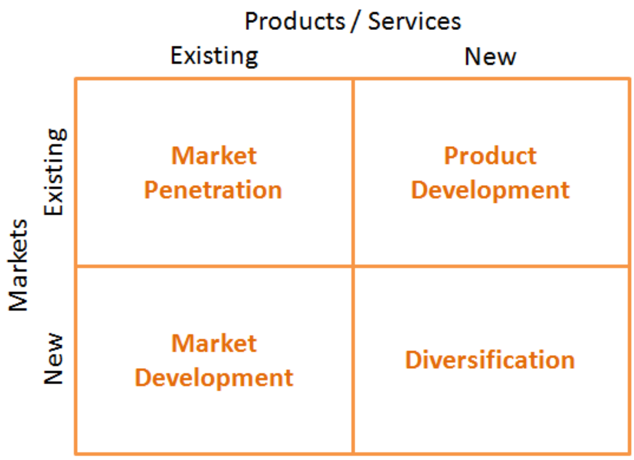


Figure 2-2. Strategies for growth. Adapted from: Ansoff (1957)

2.1.2 Scope

After an initial examination of seafood industry at an EU level against major third-country competitors, the analysis proceeds with disaggregated species level benchmarking using the tools described in the previous section.

The selection of species for analysis started with a survey of all aquatic products in the EU, in the process of which eleven aquaculture species were selected for in-depth analysis, which covered >90% of the aquaculture quantity output in 2017. The aim was to provide an EU-wide aquaculture analysis covering both freshwater and coastal/marine environments and a range of strategically important commercial species for the sector. Species were selected according to two key criteria: (i) they are representative of regional distributions (e.g. European geography, cold/warm water, marine/fresh water), and (ii) have socio-economic relevance, including production. The final list of EU aquaculture species selected for analysis was: Atlantic salmon (*Salmo salar*), rainbow trout (*Oncorhynchus mykiss*), European sea bass (*Dicentrarchus labrax*), gilthead bream (*Sparus aurata*), common carp (*Cyprinus carpio*), mussels (*Mytilus spp*), Pacific oyster (*Crassostrea gigas*), turbot (*Psetta maxima*), and good clam (*Ruditapes decussatus*). In addition, Nile tilapia (*Oreochromis niloticus*) and pangasius catfish (*Pangasius hypophthalmus*) were added to the analysis because of their strategic importance as widely traded commodities and potential competitors to white fish species produced in the EU and as raw materials for further processing (A.I.P.C.E.-C.E.P, 2019).

While production statistics are reported down to the species level, this is not always so in the case of trade statistics. Since the starting point of the analysis was apparent consumption, which requires data on both production and trade, species level data on production needed to be aggregated in order to match the minimum level of aggregation according to which trade statistics are reported[1]. The final categories of commercial species are presented in

Table 2-2. However, where possible and necessary for the analysis, the categories were disaggregated further with focus on the primary species listed above[2].

[1] For example, the CN trade statistics code (03027200) under which fresh pangasius is reported covers species other than pangaius: “Fresh or chilled catfish "Pangasius spp., Silurus spp., Clarias spp., Ictalurus spp.”. This necessitated the addition of the other together with pangasius into a broader category “Catfish” which became the minimum level of aggregation in most of the analysis

[2] For example, frozen filets of pangasius (CN code 03046200) covers only a single species “Frozen fillets of pangasius (Pangasius spp.)”, which makes it possible to a species-level analysis

Table 2-2. Composition of EU (28) production for aggregate commodities used in the analysis

Commodity	Species	Scientific name
Carp	Crucian carp	*Carassius spp*
	Bighead carp	*Hypophthalmichthys nobilis*
	Common carp	*Cyprinus carpio*
	Grass carp (=White amur)	*Ctenopharyngodon idellus*
	Silver carp	*Hypophthalmichthys molitrix*
Catfish	Pangasius	*Pangasius spp*
	Channel catfish	*Ictalurus punctatus*
	North African catfish	*Clarias gariepinus*
	Wels (=Som) catfish	*Silurus glanis*
Clam	Clams, etc. nei	*Bivalvia*
	Common edible cockle	*Cerastoderma edule*
	Grooved carpet shell	*Ruditapes decussatus*
	Japanese carpet shell	*Ruditapes philippinarum*
	Pullet carpet shell	*Venerupis pullastra*
Mussel	Blue mussel	*Mytilus edulis*
	Mediterranean mussel	*Mytilus galloprovincialis*
	Sea mussels nei	*Mytilidae*
Oyster	Cupped oysters nei	*Crassostrea spp*
	European flat oyster	*Ostrea edulis*
	Flat and cupped oysters nei	*Ostreidae*
	Pacific cupped oyster	*Crassostrea gigas*
Salmon	Atlantic salmon	*Salmo salar*
	Coho(=Silver) salmon	*Oncorhynchus kisutch*
	Huchen	*Hucho hucho*
Seabass	European seabass	*Dicentrarchus labrax*
Seabream	Gilthead seabream	*Sparus aurata*
Tilapia	Nile tilapia	*Oreochromis niloticus*
	Tilapias nei	*Oreochromis (=Tilapia) spp*
Trout	Brook trout	*Salvelinus fontinalis*
	Rainbow trout	*Oncorhynchus mykiss*
	Sea trout	*Salmo trutta*
	Trouts nei	*Salmo spp*
Turbot	Turbot	*Psetta maxima*

Source: EUMOFA (2020b)

In order to establish the extent to which aquaculture expansion can serve as a means to increasing self-sufficiency in seafood, the commercial species categories were classified on the basis of whether they could be produced in aquaculture i.e. whether technologies existed for aquaculture globally. The classification was done based on whether production was reported in aquaculture production statistics in FAO (2019) and on whether farming technologies for the species were available[3]. The list is presented in Appendix 2: Main commercial species in aquaculture.

2.1.3 Data

The data in this study cover three broad domains: domestic production, international trade and economic performance, collected from several public sources. Data were harmonised and integrated with a relational database management system (RDMS) using Microsoft Access 2016 and Microsoft Power BI 2019 (RDMS with enhanced visualisation features). The use of RDMS and Power BI made possible to integrate various sources and formats of data into a single database and allowed the flexibility of aggregating and visualising the data in a wide range of ways so that new insight on the issues of competitiveness could be derived. A significant amount of effort was dedicated to this stage of the research.

Production, trade, input-cost and other economic data were derived from seven principle data sources (Table 2-3) covering all or most of EU member states. Seafood trade statistics came from two primary sources: EUROSTAT (2019) and UN Comtrade (2019), while production statistics were collected from FAO, (2019). Data from these sources used in the model covered the period 2012-2017, due to computing and data storage capacity limitations. In the analysis, however, indicators based on the data were expressed as compound annual growth rates (see Table 2-1), in order to smooth out the year-to-year variation and isolate the trend (Chan, 2012).

Table 2-3. Raw data variables and sources

Variable	Source	Unit
Aquaculture output volume and value	FAOSTAT	Tonnes (LWE), USD
Imports (M) / Exports (X) Volume and value	EUROSTAT Easy Comext UN Comtrade	Net weight (100 kg); EUR Net weight (kg); USD
Fisheries output volume	FAOSTAT	Tonnes (LWE)
Revenue and cost variables, emplyment	STECF	EUR, No
GDP	World Bank	USD
Exchange rates	European Central Bank	Ratio; Annual average

[3] E.g. while there was no reported production of Atlantic cod (*Gadus morhua*) in aquaculture, the technologies for its production are available (Lambert and Dutil, 2001)

All production and trade statistics were reclassified according to the Main Commercial Species (MCS) classification developed by EUMOFA (2020) for the purposes of analysis of the EU seafood market, in order to harmonise the different levels of aggregation between sources, as described in the preceding section. The conversion of European Union Combined Nomenclature (CN) and United Nations Harmonised System (HS) data into MSC was achieved using the correspondence tables published by EUMOFA, (2020a) and EUMOFA, (2020c), respectively. Similarly, the capture fisheries and aquaculture production data obtained from FAO (2019) has been harmonised into the MCS classification system using the correspondence tables between ASFIS (ERS) and MSC codes (EUMOFA, 2020c).

A variety of standard product classifications exist (e.g. CPC, ISCAAP, etc), however MCS has been selected as the basis for analysis here because it allows maximum possible level of disaggregation of combined production and trade data. Another advantage is its species-centric nature, which is particularly useful to aquaculture where species-system combinations is a central aspect for development policy. An additional reason for the use of this classification system was the potential for integration with data and analysis that EUMOFA publishes regularly and which are based on this classification, which would make comparisons with EUMOFA publications possible.

Since trade data are reported in net product weight, their conversion to live weigh equivalent (LWE) was necessary in order to harmonise them with production data (reported in LWE) and to be able to make a meaningful estimation of supply balance. CN net weight trade data were converted to LWE using the conversion factors published by EUMOFA (2019a). Since no published conversion factors exist between HS product codes and MCS, EUMOFA's CN conversion factors (EUMOFA, 2019a) were also used for this classification system. This was possible because the CN classification is an extension of the HS system (HS is the root 6-digit code to which 2 more digits are added in the CN system in order to provide a greater level of detail needed for the EU trade description purposes). For the products that do not correspond exactly (i.e. more than one CN codes exist for a single HS code), an average of the relevant published CFs was calculated (can be found in Appendix 1: Conversion factors for HS codes).

The calculation of a measure of market structure (CR_4) required detailed company-level data, which was not possible to obtain for all species and countries. Such data are usually not publicly accessible (with the exception of Turkey), which necessitated the compilation of data from a variety of sources and formats (Table 2-4). This compilation of available data, as can be seen in the table, resulted in different the use of different variables and associated units, as well as period of coverage, which is due to the non-uniform availability of company-level data. When data on the output volume of production were not available, data on the value of production (as in the cases of Sea bass & bream in Spain or Pangasius in Vet Nam) or production capacity (Sea bass & bream and Rainbow trout in Turkey), was used. This should not present a significant limitation for the validity of the indicator, since the goal was to estimate a share (i.e. proportion) of the total industry. When units other than output volume are used, it is assumed that the value of the commodities, and the productivity of their assets, is roughly equal across companies. This assumption is not unreasonable because of the commodity nature, i.e. similar price and production technology (Anderson, Asche and Garlock, 2018), of these species at first point of sale.

Table 2-4. Raw data variables and sources for the calculation of concentration ratio

Species	Country	Variable	Source	Unit	Coverage
Salmon	Norway, UK, Chile, Faroe Islands, Canada, World	Output volume	Kontali Analyse (2018)	Tonnes (LWE)	2000-2015
Sea bass & bream	Spain	Turnover	Orbis (2017)	EUR	2005-2015
	Turkey	Production capacity	Republic of Turkey Ministry of Agriculture and Forestry, (2017)	Tonnes (MAB)	2010,2015, 2017
Rainbow trout	Scotland	Output volume	The Scottish Government (2018)	Tonnes (LWE)	2000-2015
	Turkey	Production capacity	Republic of Turkey Ministry of Agriculture and Forestry (2017)	Tonnes (MAB)	2010, 2013, 2015, 2017
Pangasius	Viet Nam	Export value	VASEP (2018)	USD	2010-2016

2.1.4 Limitations

The study was based on historical data with several issues arising from this:

1) scaling of data using the available technology, resulting in limited years of available data

The traditional business intelligence platform PowerBI, used for the analysis and visualisation of the results here, was based on the relational database containing structured data. The architectural design was a simple one consisting of extracting data from various sources, integrating the data and loading it into an offline storage warehouse, from which it was used to create the visualisation and analytical tools. This was done in view of adding more historical data to extend the period of analysis and updating the system with newly released data, once the architecture has been established. However, it quickly became clear that this model has significant limitations when it comes to 'big data'. The storage and computing power increase as more data is loaded into the model. This resulted in the need to limit data to only 6 years. Other, more advanced solutions, including cloud-based systems, need to be used to tackle the problem of rapidly expanding datasets and the resulting need for available computing power and storage (Barbero *et al.*, 2016).

2) the conclusions are based only on species for which there is already reported production, which excludes from the analysis species which are in very early stages of development where there is only a negligible or no amount reported, but which might have the potential to attain

socio-economic importance. This issue is addressed to some extent in the second phase by trying to understand what factors are responsible for the transformation of an industry into a commercial success and its transition from an embryonic phase to the socio-economically important mature phase.

In addition, an important limitation for a tool focused on the species as an analytical category, was the nomenclature under which trade statistics are reported. Trade statistics were used here primarily for the estimation of trade balance for each species, however, the nomenclature often does not distinguish between species but is organised around other categories of products such as based of product form or preservation: e.g. 'fillets', 'other cuts', 'frozen', aggregating the species into a broad category e.g. 'salmonids'. An example is the European seabass and gilthead seabream, which are already of significant socio-economic and strategic importance for the EU, yet, the species can only be distinguished when it is traded in a 'whole frozen' from. Fillets of seabass and seabream, which are increasingly traded across borders cannot be differentiated from other 'white fish fillets' species. Similarly, many of the products of Pacific salmon are grouped by form and preservation and, apart from Coho salmon, are not possible to trace down to the species level. It is suggested here that the categorisation is revised to collect disaggregated data for the species which are of strategic importance for the EU either as objects of production or as competitors to the EU produced species, integrated into the same market (Kinnucan *et al.*, 2003).

The tools developed in this study aimed to provide an initial "big picture" analysis of the issues of strategic importance and establish a basis for coordinated strategy development. It was not the intent of this study to capture the full complexity of the issue of competitiveness but rather to serve as a starting point, to generate ideas that could be explored in more detail with additional sources of data. The functionality can be improved by the addition of further 'modules' to expand the scope of analysis. These can include for example diversification of production, exchange rate, purchasing power parity and FAO's fish price index (Tveterås *et al.*, 2012).

The approach taken here was to add value to data by developing multiple indicators but allowing the user access to detailed and disaggregated indicator-level information, having in mind that the interaction between research and policymaking is not lineal and straight-forward, but rather complex and context specific. The same approach is unlikely to be applicable to all situations and simple tools are unlikely to capture the complexity of multi-faceted problems that are typically the target of policymaking. The aim of this investigation was to establish a basis from which the tool can be adapted to different contexts and to target users. It can be applied also to other parts of the world, including emerging economies, from which a broader picture will emerge with respect to global competitiveness.

2.2 Phase 2: Case studies

The second phase of the research makes use of case studies as means of elucidating the causes for differential performance at the level of the industry, firm and product and for providing empirical testing and feedback on the ways in which the largely quantitative platform of phase one could be improved. Since understanding the complex phenomenon of growth and competitiveness relies largely on an in-depth understanding the context in which it arises, a case study approach was the most appropriate for this area of inquiry. Case studies facilitate the understanding of dynamics and interrelations present within the single settings and at multiple levels of analysis (Eisenhardt, 1989). Yin (2014) defines case study in terms of its scope and features. With regards to its scope a case study is an empirical inquiry that "(i) investigates a contemporary phenomenon in-depth and within its real-world context, especially when (ii) the boundaries between phenomenon and context may not be clearly evident." Thus, a case study research is particularly useful when 'context' plays an important role in the understanding of the phenomenon. In fact, in real-world situations context and phenomenon are not sharply distinguishable. Therefore, as regards its features, a case study "(iii) copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result (iv) relies on multiple sources of evidence, with data needing to converge in a triangulating fashion and as another result (v) benefits from the prior development of theoretical propositions to guide data collection and analysis. Since the processes of growth, competitiveness, profitability and innovation involve many and complex processes, the use case study methodology was justified. Case studies also have considerable ability to answer 'why' and 'how' questions and are used in testing existing theories and generating new hypotheses (Yin, 2014)

However, the case study approach has been criticised for its limited capacity to generalise the results to a wider population (Mills, Durepos and Wiebe, 2010). First of all, it needs to be recognised that two different kinds of generalisation exist – statistical and analytical, which have different applications (Yin, 2014). Statistical generalisation is relevant to situations when an inference is made about a population based on empirical data collected from a sample of that population. This method is commonly used in association with surveys. However, when it comes to case studies it is usually a flaw to think of the cases as 'sampling units' and use statistical generalisation to make inferences about the wider population, because the number will be too small to serve as an adequately sized sample to represent any wider population. In this respect, the selection of cases here does not represent a purposive 'sample', because the term 'sample' refers to a wider population and requires statistical generalisation. Instead, more applicable to case study approach is analytic generalisation, which aims to shed light on theoretical concepts or principle that extends beyond the setting for the specific case that has been studied. The lessons learned could take the form of working hypotheses that can either be applied to re-interpret the results of previous case studies or define new research objectives for additional case studies. When it comes to generalisation, case study research directly parallels experimental research – new experiments are not designed as sample of a larger population of like-experiments and generalisations from a single experiment would not be in reference to a population of like-experiments (Yin, 2014).

Secondly, the case studies conducted here have utilized mixed methods approach. Qualitative and quantitative research provide different perspectives: quantitative data provide a more general understanding of a problem while qualitative data – more detailed one. Inversely, each approach has its limitations, namely deeper understanding of any one individual observation and generalizability of the results to a larger population. By mixing the approaches, the strengths and weaknesses of each approach can be balanced. In addition, mixed methods provide more evidence for studying a research problem than either qualitative or quantitative alone, allowing questions to be answered more fully.

Nonetheless, it is the nature of the qualitative approach that makes its conclusions more suggestive than conclusive. The conclusions from the case studies, do not attempt to generalise for the wider population but, in line with the prototype nature of the toolbox, to identify potential explanations of the phenomena under investigation i.e. generate hypotheses that require further investigation and well as to establish a pattern of inquiry that can be applied to other settings to further increase understanding.

All three investigations, the methods of which are outlined below (corresponding to chapters 4-6) were designed individual explanatory-sequential studies within the larger exploratory-sequential frame presented in Figure 2-1, i.e. the quantitative findings were followed by qualitative empirical data and/or discussion.

2.2.1 Sectoral level

At this stage, the phenomenon of growing and successful salmon aquaculture and stagnating trout aquaculture was chosen, on the basis of results from the benchmarking platform, as an empirical comparative context for identifying the factors responsible for the contrasting development paths of industries. The UK was the EU's largest Atlantic salmon producer and ranks third in the world by output after Norway and Chile (FAO, 2019b). On the other hand, the UK rainbow trout industry has stagnated in contrast to more successful trout sectors in other EU member states such as Denmark (Lasner *et al.*, 2017). Additionally, trout represents a useful case for analysis because of its wider spread of production across member states, as seen in the previous chapter and thus stronger potential for growth, particularly in land-locked countries, as compared to aquatic species whose production is limited to a region or a few member states. Moreover, trout production is typically situated in rural inland regions and farms are owner-operated SMEs, who will be the primary beneficiaries from a sustainable expansion of the industry, in line with the policy objectives of the EU regarding regional development. The UK presents a suitable context for a comparative case study analysis since both the salmon and trout aquaculture industries have a long history in the country. Moreover, nation states do influence the competitiveness of an industry, by policies that affect the costs of production and the quality of output. Production is regulated within a particular political structure whose basic unit is the nation state (Coe, Dicken and Hess, 2008). Similarly, countries have the ability and incentive to create conditions for imperfect completion e.g. through tariffs, non-tariff barriers and other protectionist measures.

The analysis relied primarily on secondary data and a review of relevant literature, however, findings were validated and triangulated through key informant interviews with experts in the trout farming industry, including two representatives of a trout farming business, one representative of a producers' organisation and two aquaculture researchers specializing in business and economics. Methodology for the calculation of metrics (quantitative component of the study) was as presented in section 2.1. However, two additional variables that are considered to be most characteristic of an industry's progression through its life cycle were used – annual change in production output and annual change in the number of enterprises (Klepper, 1997; Deans, Kroeger and Zeisel, 2002). This was done in order to investigate ways in which the Scottish salmon industry has changed over its history, especially in comparison to the trout industry, since the salmon aquaculture is considered the most technologically advanced and mature aquaculture industry globally (Asche, 2008). The variables were based on publicly available data for the period 1981-2017 (Marine Scotland, 2018) and expressed year-on-year (YoY) changes (%) in a 5-year rolling average. The two variables were plotted on a two-dimensional scatter plot and which was intended to serve as a notional model on the ILC development for aquaculture industries that can be applied to other aquaculture industries.

Data deficiencies at this stage included scattered data on trout industry structure across the UK administrative divisions and incomplete annual data series for trout production in the England which reached only until 2007. However, such data deficiencies did not preclude from shedding light on the structural differences between salmon industry and trout by undertaking analytical generalisation (Yin, 2014), which was the objective of the study at this stage. It is this explanatory understanding, which can have wider application going beyond the specific case studies, that informs strategy, and not the data of the specific cases. In this sense, an important data limitations included the lack publicly available of financial data (costs and revenues) for trout farms that could be used to calculate the productivity and profitability metrics important in the analysis of competitiveness (Peneder, 2009). That was due to the small size of trout farms and therefore their exemption from preparation and publication of detailed financial reports. This was in contrast to the financial data available for salmon producing companies, which was formed part of the analysis in the chapter 5.

2.2.2 Firm level

In this level of the investigation, quantitative investigating of the profitability in the salmonid value chain in the UK, formed the first stage of the design and was followed by a multiple case study explanatory stage. In this phase qualitative and quantitative data were used to form three company-level case studies aiming to explain the drivers of profitability for SMEs.

An analysis of profitability along the UK salmonid value chain was performed by examining industry level profit margins for the three main links of the value chain: aquafeed manufacturing, farming and salmon/salmonid processing.

Profit margin at the industry level was calculated as follows:

Profit margin (%) = [Profit (Loss) before tax / Turnover]* 100

Profit (Loss) before tax = Operating profit + Total other income + Exceptional items – Interest paid

Financial accounts data were collected from the business intelligence database FAME (FAME, 2019), for all companies for which data was available for the period 2008-2017, under the following industries codes: 032 – Aquaculture and 102 - Processing and preserving of fish, crustaceans and molluscs (European Commission, 2008). On the basis of 2017 data, and additional information from the companies web-sites, the companies for which data was available, were classified into categories according to value chain stage (aquaculture and aquafeed manufacturing) and size (SME and Large). For aquaculture companies the classification was further disaggragated into type of aquaculture (salmonid or other), while processing companies were also classified into ‘salmonid‘ processing (processing only or mostly salmon and/or trout) and ‘other‘ (all other types of processing, including salmonid but where it was not the main focus of activity). Only the marine salmonid aquaculture (i.e. trout and salmon) and salmonid processing companies were analysed here. In 2016 the total number of processing companies using salmon as raw material (whether or not salmon was the focus of processing) were 28, of which 13 companies focused on salmon (or salmonid species) and 15 companies used salmon together with other species in a diversified portfolio of species-products. However, company accounts do not breakdown the profitability according to species and products, and accordingly it was not posible to attribute the profit due to salmon processing in companies with mixed raw material. Therefore these were excluded from the analysis. The number of firms in each category is presented in Table 2-5.

Table 2-5. Distribution of companies for profitability analysis

Value chain stage	2008	2009	2010	2011	2012	2013	2014	2015	2016
Aquaculture*	**6**	**6**	**7**	**7**	**8**	**8**	**8**	**8**	**8**
Large**	4	4	4	4	5	5	5	5	5
SME	2	2	3	3	3	3	3	3	3
Feed	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**
Large	3	3	3	3	3	3	3	2	3
Processing	**9**	**9**	**9**	**10**	**9**	**10**	**12**	**11**	**13**
Large	2	2	2	3	3	3	3	3	3
SME	7	7	7	7	6	7	9	8	10

*Aquaculture contains 1 SME marine trout farming company, the rest were salmon companies. **The Classification of company size is based on staff count and annual turnover according to European Commision (2015): SME (<250 FTE; ≤ € 50 m) and Large (≥250 FTE; > € 50 m).

Following the quantitative component of the analysis, three company-level case studies of firms within the UK salmonid value chain were conducted with the aim to uncover the relationship between industry structure (external factors), company resources and capabilities (internal factors) and strategic positioning. The cases covered two salmonid species – Atlantic salmon and rainbow trout reared in marine net cages, and two stages of the salmonid value chain – farming and processing. After investigating the range of busineses in these sub-sectors, three more or less profitable vertically integrated SMEs were purposively selected as examples of strategic positioning resulting in successful and unsuccessful competitve outcomes (Table 2-6).

Table 2-6. Selection of company-level strategic positioning cases

Comapany	Species	Value chain stage	Turnover (GBP million)	Reasons for selection
A	Atlantic salmon	Production (marine cages) and value-added processing	15.8 (2018)	Successful adaptation to a changing competitive environment through market differentiation, resulting in improved profitability (phase 1)
B	Rainbow trout	Production (mostly marine cages), primary and value-added processing	15.8 (2019) (farming) 73 (total)	Unfavourable strategic positioning resulting in repeated losses
C	Atlantic salmon and rainbow trout	Primary and value-added processing only	33.1 (2018)	Unfavourable strategic possition resulting in bankruptcy

The development of case studies involved mixed methods, utilising both quantitative and qualitative data. The data for each case study was collected from secondary sources and through semi-structured interviews with company representatives and key informants. The sources of secondary data included company accounts, accessible through the business intelligence database FAME (2019), trade journals and mainstream newspapers covering information on the selected companies. The evidence was organised and analysed using Nvivo 2017. Results were validated and triangulated in discussion with key informants with industry and research experience.

2.2.3 Product-level (innovation)

In this study, quantitative investigation of the product-level innovation in the European seafood industry to uncover the trends in innovation was followed by multiple case studies of new product-development aiming to uncover the “mechanisms” of innovation in the firm context and strategy and the reasons for its commercial success or failure from the viewpoint of the firm[4].

The main source of quantitative data for the detailed product innovation practice across Europe was the Global New Products Database (GNPD) constructed by Mintel, a market intelligence agency (Mintel International Group, 2016). The database covers detailed information on new products launched on the consumer goods market, including seafood products. However, it only includes packaged products, marketed in shops and online. In addition, the product must feature 'new' on its label to be included in the database. Thus, a limitation linked to the coverage of the Mintel Database and the generalisations that can be drawn from it, needs to be recognised. New products sold this claim distributed through the retail sector and all food service sector products were not included in this analysis. Therefore, the conclusions of this first section are restricted to this specific set of products. While precise estimates of what proportion these products represent in the total is not possible, the practice of including a 'new' claim on new products seems to be common. This is likely so because new products, particularly if introduced by smaller and less known companies, find it difficult to get shelf space, since they need to take away space from products with proven sales records. To increase the chances of consumer recognition and commercial success, new products are often accompanied by some form of advertising (Fuller, 2016). The claim 'new' on the package of a product is a simple and cost-effective form of advertising which does not require subsequent modification of the package but can simply be removed from it if the product remains on the shelves for longer periods. The method of developing a database of new retail seafood products on the basis of the claim 'new' is also practiced by the Seafish Authority in the UK (Seafish, 2020).

In the context of the food industry, innovation can include new products, new types of packaging (including both the physical characteristics of packaging and the contents of information on it, new recipe (new flavours, new additives, conservation methods), range extension, re-launch, new marketing methods and implementation of a new or significantly improved logistical process (ECSIP Consortium, 2016). Accordingly, the Mintel database distinguishes between five different categories of product innovation which imply very different effort, knowledge and resources on the side of the innovating firm. According to Mintel International Group (2012) a "new product" corresponds to a new line or family of products for

[4] However, as pointed out by Grunert et al. (1997) those figures may be overstated since the definition of success, usually measured by the period which a product has been on the market, is not standard, and indeed a product may be successful even though short lived, depending on its intended function. For example, a range of products can be introduced by a company to diffuse the success of a new product launch by a competitor, being consequently withdrawn but nevertheless strategically successful.

a particular brand. This kind of launch is brand dependent. It also includes brand products that are launched in a new country where the product has not been present. A "new packaging" is based on the visual aspect of the product; it corresponds to product labelled as "new look", "new size" or "new packaging". A "new formulation" concerns the new ingredients or formulation of an existing product. A "new variety" is assigned when an innovation represents a horizontal extension of an existing brand line. Finally, a "re-launch" is assigned to an innovation when this is indicated on the product packaging, or when a secondary information source informs consumers (trade show, website or press), that a product is re-launched. It is also assigned when the product has been both reformulated and presented in a new packaging. While different categories of innovation have been developed and are discussed in the literature, amongst which categories relating to the extent of novelty such as 'radical' or 'incremental' innovation (Bhaskaran, 2006), its impact on the market such as 'sustaining' or 'disruptive' (Christensen *et al.*, 2015), in this study, following a resource-based view (Barney, 2000), the focus was on the nature of innovation under the assumption that some innovations are more resources-intensive (such as developing an entirely new product) than others (e.g. re-launch). Similarly, the risk of market introduction is not the same across different categories, e.g. 'new product' category is considered more risky because there is no previous data on which estimations of future performance might be based, whereas for products that have already been on the market (or close variants of these products) such estimations are to a great extent possible (Fuller, 2016). Moreover, innovation in packaging, which plays an essential role within the food sector, has received considerable attention from scholars (Earle, 1997). In terms of product-level detail including packaging. Moreover, innovation in packaging, which plays an essential role within the food sector, has received considerable attention from scholars (Earle, 1997). In terms of product-level detail including packaging, the Mintel GNPD database surpasses its main competitor – the Euromonitor's Global Market Information Database, which is why GNPD Mintel is preferred and often used in academia (Solis, 2016). Personal in-store product observations have been used in other studies to supplement data obtained from commercial data providers (Roheim, Asche and Santos, 2011a; Sogn-Grundvåg, Larsen and Young, 2014), however, due to the wide coverage and resource limitations of this study, personal in-store observations were not possible. Here, new food products launched on the European market, containing seafood[5] as one of the product's top five ingredients by volume were analysed using Mintel data (Mintel International Group, 2016). The European market comprises the 25

[5] Seafood products is used here as a generic term encompassing all food products with the main component originating from the aquatic environment, including fin-fish, crustaceans, molluscs or plants.

countries covered by Mintel: Germany, Austria, Belgium, Croatia, Denmark, Spain, Finland, France, Greece, Hungary, Ireland, Italy, Norway, Netherlands, Poland, Portugal, Czech Republic, Romania, United Kingdom, Russia, Slovakia, Sweden, Switzerland, Turkey and Ukraine.

As for the development of product-level case studies – the explanatory part of the design – the selection of cases was done in two stages. Firstly, an inventory of seafood product innovations introduced on the EU market between 2010 and 2016 was compiled from secondary data (newspapers, company sites, specialized literature, innovation awards, etc) and formed a frame from which cases were selected for in-depth analysis. After careful cross-checks with databases such as GNPD, Lexis Nexis[6] and consultation with professionals in the field, seafood trade-show management and representatives from each EU country, 60 potential cases were identified to comprise the inventory. The inventory was limited to six fin-fish species of major importance to the EU aquaculture and fisheries sectors and regional markets, which were expected to have different potential for value addition. The species were: Atlantic salmon (*Salmo salar*), rainbow trout (*Onchorynchus mykiss*), sea bream (*Sparus aurata*), European sea bass (*Dicentrarchus labrax*), cod (*Gadus morhua*) and herring (*Clupea harrengus*). A firm producing shrimp[7] in the EU and a product based on imported pangasius were also included in the final case study selection (see below). Additionally, as the scope for innovation was expected to vary with the firm's value chain position, firms covering production, primary and secondary processing and combinations of those were included. The countries covered by the case studies were: Italy, UK, France and Germany, as major EU country producers and/or seafood markets (EUMOFA, 2016).

Secondly, with the help of industry experts (including a seafood trade show organiser with thorough knowledge of the seafood products on the market), the list was narrowed down to 10 cases for which in-depth studies were developed. The number of in-depth case studies was restricted by the resource limitation of the project as well as access to and availability of senior company representatives for interviews. The final selection strived to distribute the cases as widely as possible across variables such as country, species, type of innovation (according to Mintel definitions), marketing claims, place of innovation along the firm's value chain, firm size[8], and outcome of the innovation. The location (country) and species dimensions of this selection were also influenced by the objectives of the Primefish project (PrimeFish, 2018), of which this

[6] http://www.lexisnexis.com/hottopics/lnacademic/

[7] High perceived value does not always correspond to higher levels of processing. In this case the value of the product related primarily to its freshness and local origin

[8] Enterprises have been classified according to definitions by European Commision (2015) based on staff count and annual turnover into the scales: micro (<10; ≤ € 2 m), small (≥10, <50; > € 2 m ≤ € 10 m), medium (≥50, <250; > € 10 m, ≤ € 50 m) and large (≥250; > € 50 m).

research was part. A general summary of the selected cases can be found in Table 2-7.

Following the selection of the cases, multiple types of data sources were used to develop the case studies: interviews and publicly available information e.g. news releases, company websites (Yin, 2014). During one of the interviews an on-site observation of the production facilities (aquaculture farm and value-addition unit) was made. Personal observation can be a valuable method of supplementing data obtained from other sources (Roheim, Asche and Santos, 2011a; Sogn-Grundvåg, Larsen and Young, 2014). Interviews were conducted using a semi-structured questionnaire, developed on a basis of a modified food product case-study guideline by Harmsen, Grunert and Declerck (2000). Topics covered included company history and overview, perceptions about innovation, innovation practices, sources of innovation, challenges and drivers for innovation and covered the last three-year period. The aim of the interview was to understand the reasons for success or failure of the selected product within the wider innovation efforts and growth strategies at the company. The semi-structured interviews were conducted with company owners or senior employees (general manager, sales/marketing manager, quality manager), who were selected for interview due to their broad knowledge of the company, its strategy and the processes linked to new product development. The interviews were conducted at the firms selected, in the local language, with the help of an interpreter where necessary and lasted between 1.5 and 2 hours.

Results were recorded in note form, backed up with a voice recording with the permission of the interviewee, subsequently transcribed and analysed using a cross-case synthesis approach (Yin, 2014) with the help of NVivo 11 Pro software. Commitments to the ethics policy of the Primefish project, allowed the presentation of results only in aggregated form, which necessitated the use of cross-case study analysis. Cross-case study synthesis can be applied when more than one case study has been conducted and each case has been conducted as independent research. The technique aggregates findings across a series of individual studies. Thus, the findings are likely to be more robust than working with only a single case (Yin, 2014).

Table 2-7. Summary of product innovation case studies

CASE	MAIN SPECIES	MARKET	DISTRIBUTION CHANNEL	COUNTRY	FIRM SIZE	TYPE OF FIRM	COMPANY VALUE CHAIN	SHORT INNOVATION	INNOVATION	MAJOR CLAIM	OUTCOME
A	Trout	Domestic, Europe	Multiple retail, local shops	Italy	Small	Cooperative	Aquaculture; Primary & Secondary Processing; Logistics	Trout fillet (new to company)	NP	N, H, Local	Success
B	Trout	Domestic, Europe	Multiple retail, local shops	Italy	Small	Private company	Aquaculture, Primary and Secondary Processing	1) Boneless fillet 2) Ready to eat healthy product recipe	NP NP	C H	Success Failure
C	Pangasius	EU	Multiple retail, wholesale	Viet Nam	Large	PLC	Aquaculture, Primary & Secondary Processing, Export	Breaded, ready to cook / ready to eat fillets	NP	C, S	Success
D	Salmon	Domestic	Multiple Retail, Food service	Italy	Small	Private company	Secondary Processing	New method of smoking, imparting unique flavour	NR	Taste	Success
E	Sea bass	Domestic	Multiple retail, Food service	Italy	Small	Private company	Secondary Processing	New recipe for a convenience easy to cook product	NR	C	Success
F	Salmon	Domestic	Multiple retail	France	Large	PLC	Secondary Processing	Convenience packaging	ExtR	N, C, S	Success
G	Herring	Local	Multiple retail	France	Small	Private company	Primary & Secondary Processing	Novel use of species as an ingredient in 'quenelles'	NR		Failure
H	Salmon, Seabass, cod	International	Multiple retail, direct to consumer	UK	Large	Private company	Primary & Secondary Processing	Fillet with sauce, ready to cook	NPa, NR	C, S	Success
I	Tropical shrimp	Domestic	Direct to consumer	Germany	Micro	GmbH & Co. KG	Aquaculture, Marketing	Locally produced shrimp	NP	Fresh	Success

Firm size: micro (<10; ≤ € 2 m), small (≥10, <50; > € 2 m ≤ € 10 m), medium (≥50, <250; > € 10 m, ≤ € 50 m) and large (≥250; > € 50 m)

Innovation: NP=New product, Npa=New Packing, NR=New recipe, ExtR=Ext. Range; **Major claim**: C=Convenience, N=Natural, H=Health, S = sustainable/ethical

Chapter 3: Strategic decision-making support tools for the EU seafood sector

3.1 Introduction

The development of an effective growth strategy for the aquaculture sector requires consideration of a large number of inter-connected issues and the reconciliation of often conflicting objectives (Nash, 1995). There is a need for the application of systems thinking – viewing units as interlinked in a wider system where a change in one component of the system would affect the other parts as well (Cabrera, Colosi and Lobdell, 2008) - in addressing the complex challenges of sustainable aquaculture development, in addition to greater availability and use of evidence for policy making (Stead, 2019).

The effectiveness of the open method of coordination (OMC), as discussed in chapter 1 rests on the principle of benchmarking and coordination across member states (Szyszczak, 2006). However, currently, there is no unified benchmarking tool of platform to assist policy makers in this practice. Implicit comparisons between MSs are made in different EU publications targeting specific aspects of analysis. Such publications include the biannual 'Economic Report of the EU Aquaculture Sector' by the EU Joint Research Centre's (JRC) (Nielsen, Carvalho and Guillen, 2018) and the annual edition of the "EU Fish Market" report by EUMOFA (EUMOFA, 2019c). While such publications contain comparisons between MSs and species (or species groups), their main objective is to provide information on the 'current state' or an 'overview' of the industry, leaving strategic implications to be discerned by the user.

Indicator-based approaches have been used in a variety of economic sectors and contexts (Rose *et al.*, 2016) but remain an under-explored area in aquaculture, especially with respect to issues other than environmental impacts of aquaculture (Volpe *et al.*, 2013; Gomes Ferreira *et al.*, 2020). Economic performance and competitiveness-related indicators in the context of aquaculture have been identified by Hofherr, Natale and Fiore (2012), Bostock *et al.* (2009) and Cai, Leung and Hishamunda (2009), while a more systematic application of indicators to EU aquaculture can be found in the EU Joint Research Centre's (JRC) economic report (Nielsen, Carvalho and Guillen, 2018).

Open source analytical tools relevant to markets and competitiveness of the EU seafood industry are offered by (EUMOFA, 2020a), albeit mostly in the form of raw data collations and dissemination and the periodic release of focused reports, such as the annual "EU Fish

Market" report (EUMOFA, 2019c). Similarly, a variety of publicly accessible sources of raw data on topics related to competitiveness and strategy in aquaculture, such as patterns of production (FAO, 2019c), international trade (EUROSTAT, 2019; UN Comtrade, 2019), economic performance data underlying the JRC Economic Report (Scientific Technical and Economic Committee for Fisheries (STECF), 2018). Each of these sources adopts its own nomenclature, limiting the interoperability of the data (i.e. its ability to be used in conjunction with other sources of data). Moreover, the data sources remain scattered across multiple locations and reach the user in different formats, which limits its usability and applicability to strategy and policy making. Thus, there appear to be unexploited opportunities for combining and harmonising these data sources (Janger *et al.*, 2018).

At the same time, being in the information age, the opportunities for using new technologies in support of evidence-based policy making has never been greater. Evidence-based policy is "a systematic approach that helps people make decisions about policies, programs and projects by putting the best available evidence from research at the heart of policy development and implementation" (Barbero *et al.*, 2016). New technologies, which can broadly be grouped into the term 'big data', allow the processing of vast amounts and varieties of data into information systems relevant for policy making, through statistical analysis and modelling to find new insights and efficiently deal with the complex policy issues that policy makers are faced with. Technologies have already being rapidly adopted by the private sector while the public sector is still lagging behind in this respect (Barbero *et al.*, 2016). The increasing amount of data that is becoming more readily available, together with the new and evolving technologies and tools for processing and analysing them to draw insight, can have a major impact on policy making. As detailed in the previous chapter, it is the aim of this study to contribute to filling these gaps, in light of the EC's guidelines concerning 'Enhancing the competitiveness of EU aquaculture' (European Commission, 2013b).

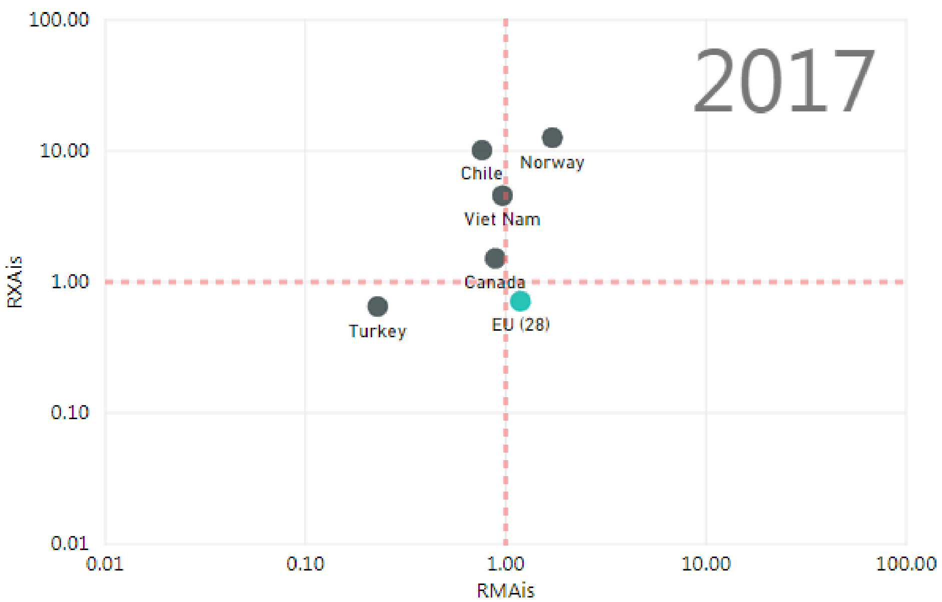
3.2 Results

This section begins with an examination of comparative advantage for all seafood as an aggregate commodity at the EU and member states level. Then it proceeds with an overview of the EU seafood market and production by species from which the species-level scope is for the analysis in consecutive sub-sections is defined. The results from the other performance and competitiveness metrics are organised in two main categories: market-related and production-related.

3.2.1 Revealed Comparative Advantage (RCA)

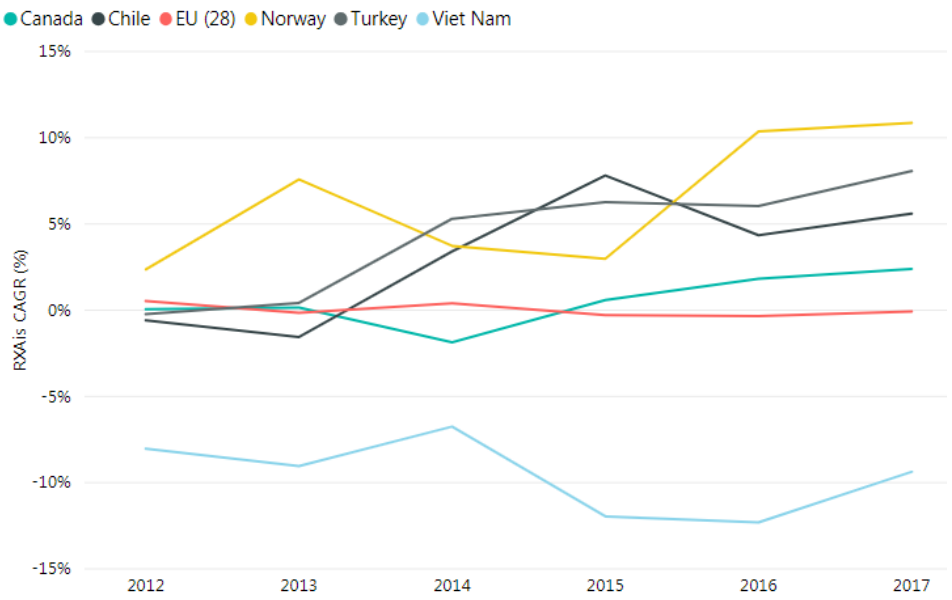
The results of the analysis of revealed comparative advantage (RCA) show that in 2017 the EU28 scored < 1.0 on seafood (as an aggregate commodity) in terms of exports but >1.0 on imports (Figure 3-1). In all other reference nations, apart from Turkey, the patterns of trade reveal specialisation on seafood through export, as signified by values > 1.0. The rate of change in RCA (exports) for the EU28, has remained stable, near 0%, for the period 2012-2017, as seen in Figure 3-2.

When decomposed to member state level, the results show a high level of diversity within the EU28 the region in terms of revealed comparative advantage, Figure 3-3. Ten MS (Sweden, Denmark, Portugal, Greece, Lithuania, Spain, Cyprus, Estonia, Poland and Croatia) score above 1.0 on RXA, of which all except Croatia score above 1.0 also on the RMA indicator. These results indicate a relatively high level of specialisation on seafood and thus the important role the industry plays in the overall economies of these states. In the case of Sweden, however, which has the highest scores of all MS, the result can be interpreted as a consequence of the proximity of the country to Norway, from where large quantities of seafood imports enter the EU and are consequently re-exported to other member states (as seen in later sections).



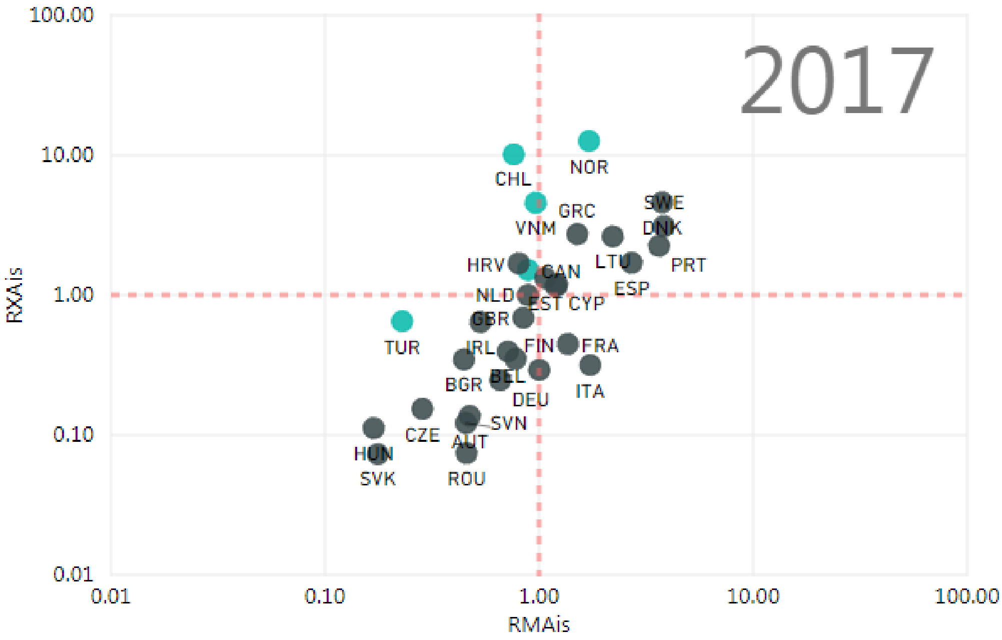
In the case of EU28 trade refers to third countries only. Source: Eurostat (2019), UN Comrade (2019)

Figure 3-1. Revealed seafood export (RXA) and import (RMA) advantage for EU28 and selected competitors



Source: Eurostat (2019), UN Comrade (2019)

Figure 3-2. Compound annual growth rate (CAGR) in the revealed comparative advantage for seafood (RXA) for the EU28 and reference countries

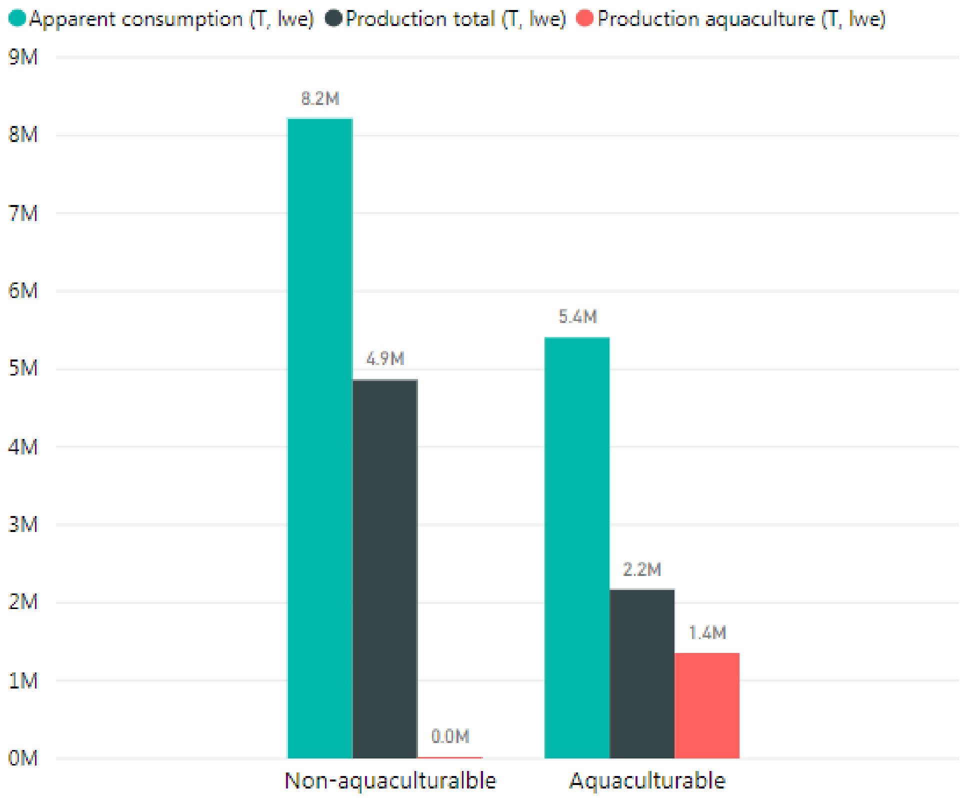


Source: Eurostat (2019), UN Comrade (2019)

Figure 3-3. Revealed seafood export (RXA) and import (RMA) advantage for EU28 by member state and selected competitors

3.2.2 Sector composition

The total size of the EU seafood market in 2017 was 13.6 million tonnes, lwe. Of which some 5.3 million tonnes, or 38%, consisted of products that could be produced by aquaculture. Within this category ('aquaculturable'), the EU28 reported a total production for 2017 of 2.1 million tonnes, of which some 1.35 million tonnes (or 10% of the total seafood market) actually originated from EU aquaculture, Figure 3-4.



Source: EUROSTAT (2019), FAO (2019)

Figure 3-4. Split of apparent consumption, total seafood production (fisheries and aquaculture) and aquaculture production in the EU28 in 2017

A breakdown of the 'aquaculturable' category into species (Table 3-1), revealed that the total EU28 aquaculture production volume in 2017 accounted for 24% of the total consumption volume (lwe) of the same species. Important commercial species which can be produced in aquaculture but for which there was no or negligible EU production, include cod and shrimp. The commodities highlighted in red were selected for the analysis that follows; they represented 97% of the total aquaculture production in the EU.

Table 3-1. Apparent consumption, imports and EU28 aquaculture production of 'aquaculturable' species in 2017

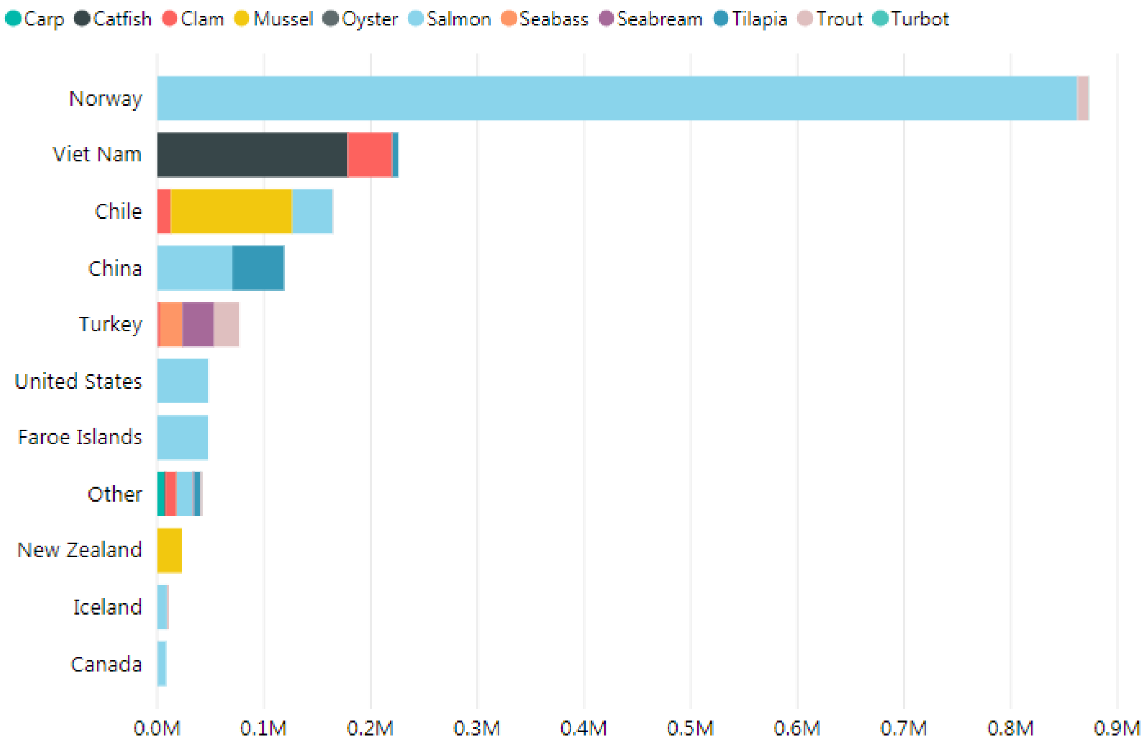
Species	Apparent consumption (T, lwe)	Imports volume (T, lwe)	Share of total EU28 import volume (%)	Imports value (EUR'000)	Share of total EU28 import value (%)	EU28 aquaculture production volume (T, lwe)	Share in total EU28 aquaculture production volume (%)	EU28 aquaculture production value (EUR'000)	Share in total EU28 aquaculture production value (%)
Cod	1,178,429	1,158,874	28.38%	2,463,276	16.1%				
Salmon	1,145,977	1,097,878	26.9%	6,100,271	39.7%	209,230	15.5%	1,336,324	29.1%
Mussels	666,688	137,165	3.4%	145,897	1.0%	493,844	36.5%	431,555	9.4%
Shrimp, miscellaneous	364,818	367,021	9.0%	1,814,787	11.8%	204	0.0%	938	0.0%
Shrimp, warmwater	346,558	346,584	8.5%	2,289,854	14.9%	103	0.0%	1,854	0.0%
Other marine fish	317,748	339,351	8.3%	873,294	5.7%	8,030	0.6%	45,005	1.0%
Trout	214,680	38,094	0.9%	148,864	1.0%	190,812	14.1%	667,412	14.6%
Catfish	186,307	179,736	4.4%	175,461	1.1%	10,200	0.8%	23,362	0.5%
Clam	170,755	67,527	1.7%	79,978	0.5%	43,071	3.2%	155,126	3.4%
Other freshwater fish	145,698	62,953	1.5%	209,354	1.4%	16,782	1.2%	68,168	1.5%
Scallop	141,625	91,298	2.2%	241,514	1.6%	19	0.0%	152	0.0%
Seabream	125,702	31,111	0.8%	132,770	0.9%	95,390	7.1%	481,452	10.5%
Carp	102,054	7,035	0.2%	16,115	0.1%	87,484	6.5%	185,555	4.0%
Seabass	100,730	20,640	0.5%	101,491	0.7%	79,350	5.9%	489,128	10.7%
Oysters	79,036	239	0.0%	2,101	0.0%	83,971	6.2%	399,413	8.7%
Crab	78,387	30,716	0.8%	126,095	0.8%	11	0.0%	8	0.0%

Table continues on next page

Seaweed and other algae	76,326	-	0.0%	23,286	0.2%	246	0.0%	3,297	0.1%
Molluscs and aquatic invertebrates, other	61,664	23,870	0.6%	76,254	0.5%	95	0.0%	392	0.0%
Tilapia	59,027	59,844	1.5%	62,907	0.4%	215	0.0%	669	0.0%
Seabream, other	43,707	6,916	0.2%	37,774	0.3%	1,612	0.1%	11,066	0.2%
Sole, common	24,279					6	0.0%	52	0.0%
Turbot	17,410	253	0.0%	2,277	0.0%	11,571	0.9%	80,989	1.8%
Other salmonids	15,564	2,351	0.1%	7,795	0.1%	5,844	0.4%	35,688	0.8%
Sole, other	12,890	4,188	0.1%	19,902	0.1%	1,438	0.1%	15,635	0.3%
Tuna, bluefin	11,309	4,167	0.1%	44,973	0.3%	6,616	0.5%	87,969	1.9%
Pike	10,938					428	0.0%	1,970	0.0%
Eel	10,022	1,932	0.1%	18,518	0.1%	5,938	0.4%	60,688	1.3%
Pike-perch	8,342					645	0.1%	4,146	0.1%
Halibut, Atlantic	2,458	2,448	0.1%	19,498	0.1%				
Abalone	126	86	0.0%	796	0.0%	8	0.0%	157	0.0%
Cobia	7	108	0.0%	960	0.0%				
Caviar, livers and roes		-	0.0%	109,649	0.7%				
Freshwater crayfish		296	0.0%	1,746	0.0%	33	0.0%	346	0.0%
Seabass, other		142	0.0%	691	0.0%	-	0.0%	1	0.0%
Sea cucumber		51	0.0%	815	0.0%				
Totals	**5,719,261**	**4,082,874**	**100%**	**15,348,963**	**100%**	**1,353,196**	**100%**	**4,588,517**	**100%**

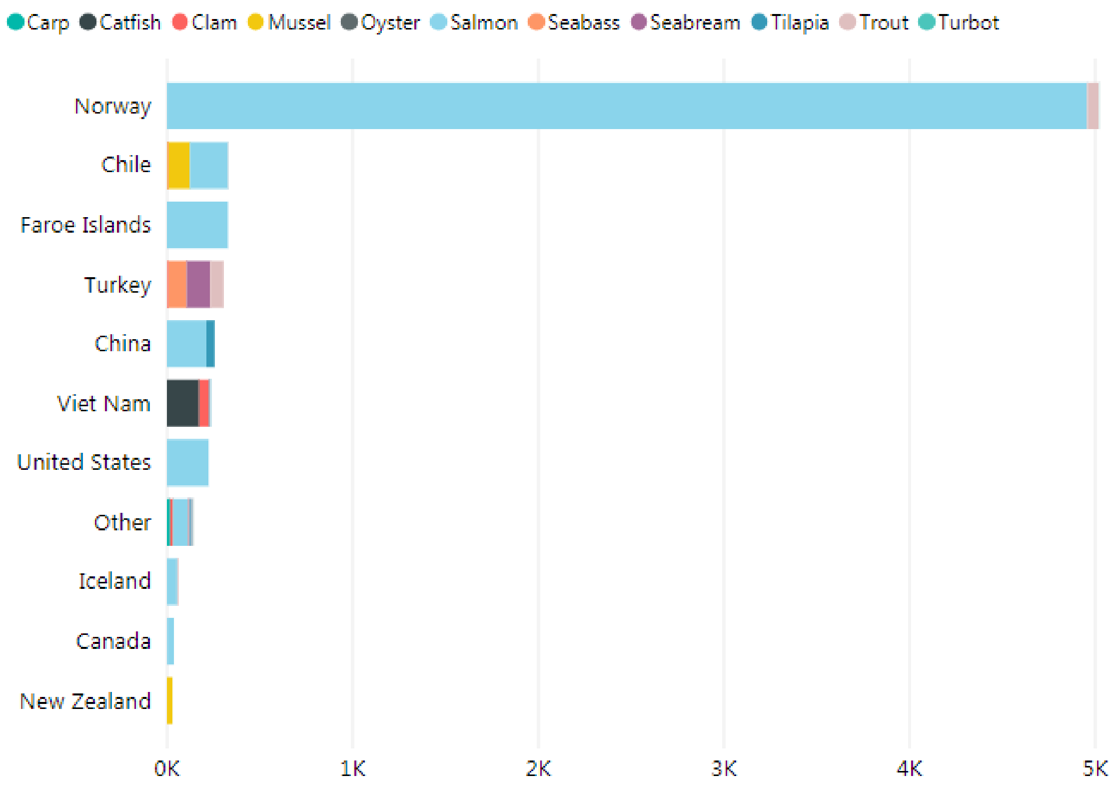
Species selected for further analysis are highlighted in red. Source: EUROSTAT (2019), FAO (2019)

As seen in Table 3-1, considerable amount of the EU market for species that can be produced in aquaculture was met through imports. A large proportion of the imports of the selected aquaculture species by volume consisted of Norwegian salmon (Figure 3-5), which also had by far the largest share in terms of value (Figure 3-6). Other main sources of salmon imports were China, Chile, United States and the Faroe Islands. Viet Nam was the main source of pangasius catfish imports and Chile of mussels. Turkey was the main exporter of seabass, seabream and trout to the EU market.



Data source: EUROSTAT (2019)

Figure 3-5. EU28 import volume (T, lwe) of selected main commercial species by third country source (top 10) in 2017



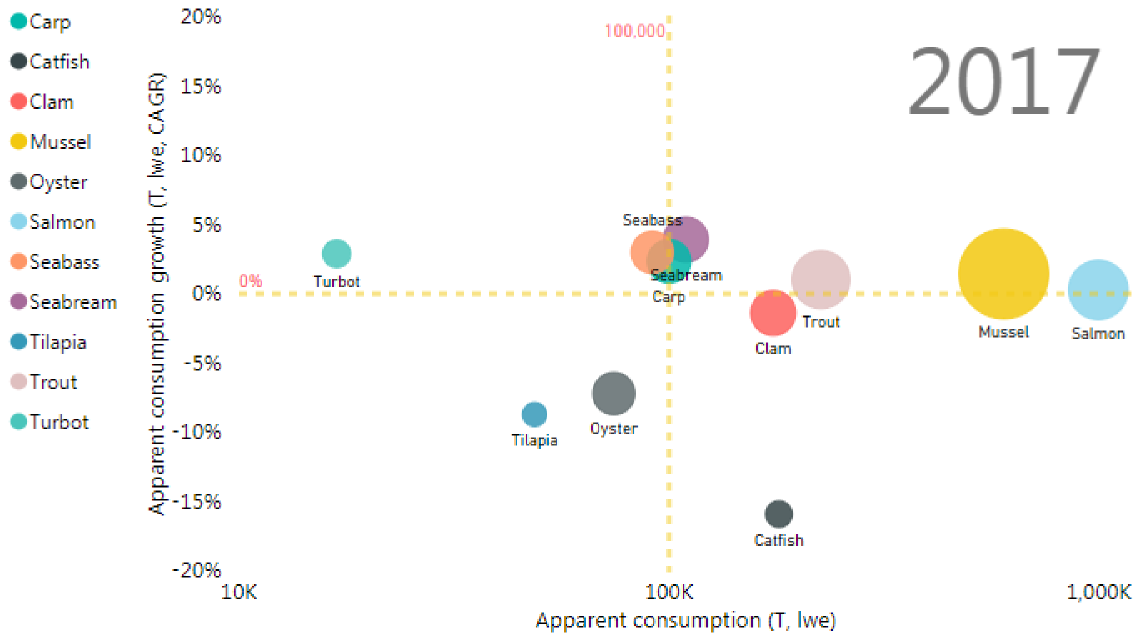
Data source: EUROSTAT (2019)

Figure 3-6. EU28 import value (EUR Million) of selected main commercial species by third country source (top 10) in 2017

3.2.3 Market opportunities and threats

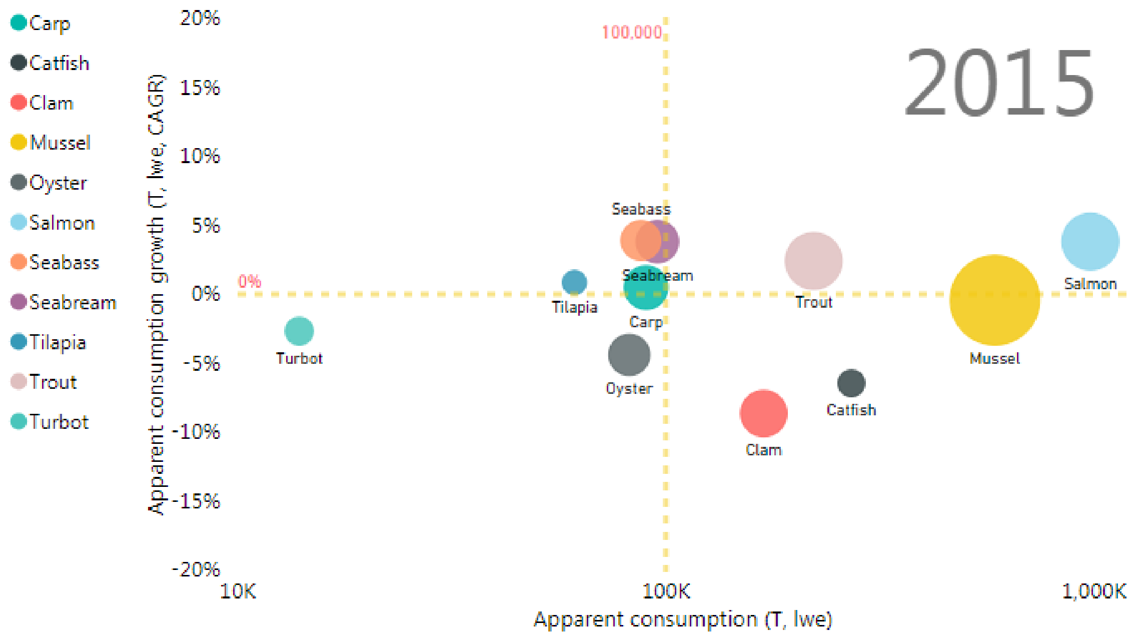
3.2.3.1 Market size

The apparent consumption of selected commodities in the EU28 in 2017 is shown in Figure 3-7. None of the commodities examined had a CAGR higher than 5%, whereas Clam, Tilapia, Oysters and Catfish showed a negative growth rate for the period 2015-2017. Salmon had the largest market of nearly 1 million tonnes (lwe), however it exhibited a static consumption rate of 0% (down from 4% CAGR in 2015). Mussels was the second largest market by live weight with 600,000 t, showing a positive trend in consumption in the period 2015-2017. Seabass, Seabream and Carp had similar market sizes of around 100,000 tonnes lwe. Turbot and Tilapia had the smallest apparent consumption of 17,000 t and 49,000 t lwe, respectively. A decline in consumption of Catfish, Tilapia and Oysters can be observed relative to 2015, while the opposite trends was found seen in the case of Mussels, Carp and Turbot (Figure 3-8).



Bubble size indicates EU28 production by volume; horizontal axis is on a log-scale. CAGR – compound annual growth rate, based on three-year interval. Data sources: EUROSTAT (2019), FAOSTAT (2019), EUMOFA (2019)

Figure 3-7. Apparent consumption (T, lwe) of selected commodities on the EU market, 2017

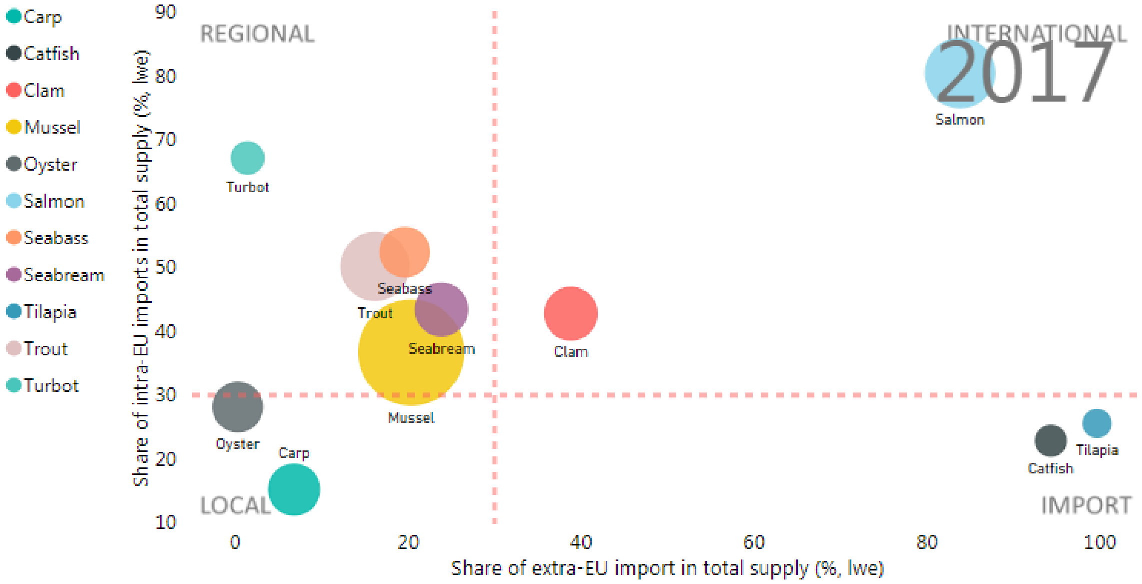


Bubble size indicates EU28 production by volume; horizontal axis is on a log-scale. CAGR – compound annual growth rate, based on three-year interval. Source: EUROSTAT (2019), FAOSTAT (2019), EUMOFA (2019)

Figure 3-8. Apparent consumption (T, lwe) of selected commodities on the EU market, 2015

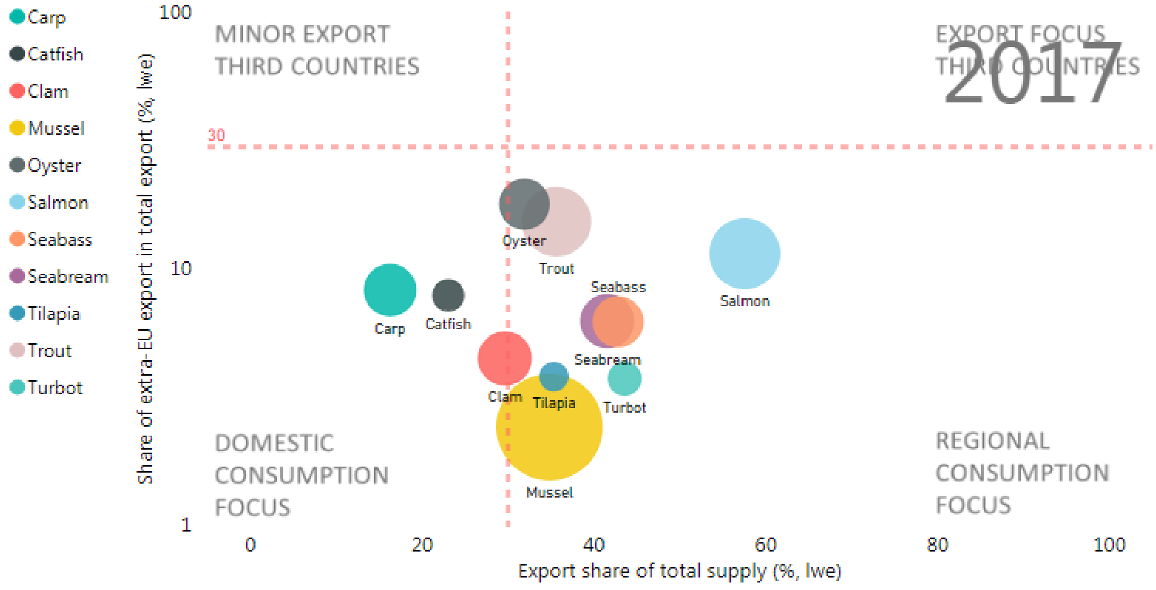
3.2.3.2 Market globalisation

The extent and geographic scope of trade with the selected commercial species on the EU market is shown in Figure 3-9 and Figure 3-10. Salmon showed high trade level on both dimensions, reflecting the global market for this commodity. Catfish and Tilapia were supplied almost exclusively from third countries, while very low levels of trade in Carp, both external and internal, were found. However, most commodities were characterised by low levels of third-country imports and exports but significant intra-EU trade indicating regional (within EU) consumption and competition. No major differences in the trends of import and export sourcing were found between 2015 and 2017.



Bubble size indicates EU28 production by volume; Data source: FAO (2019), EUROSTAT (2019)

Figure 3-9. Geographic extent of import sourcing of selected commercial species on the EU28 market, 2017



Bubble size indicates EU28 production by volume; horizontal axis is on a log-scale. Source: EUROSTAT (2019), FAO, (2019)

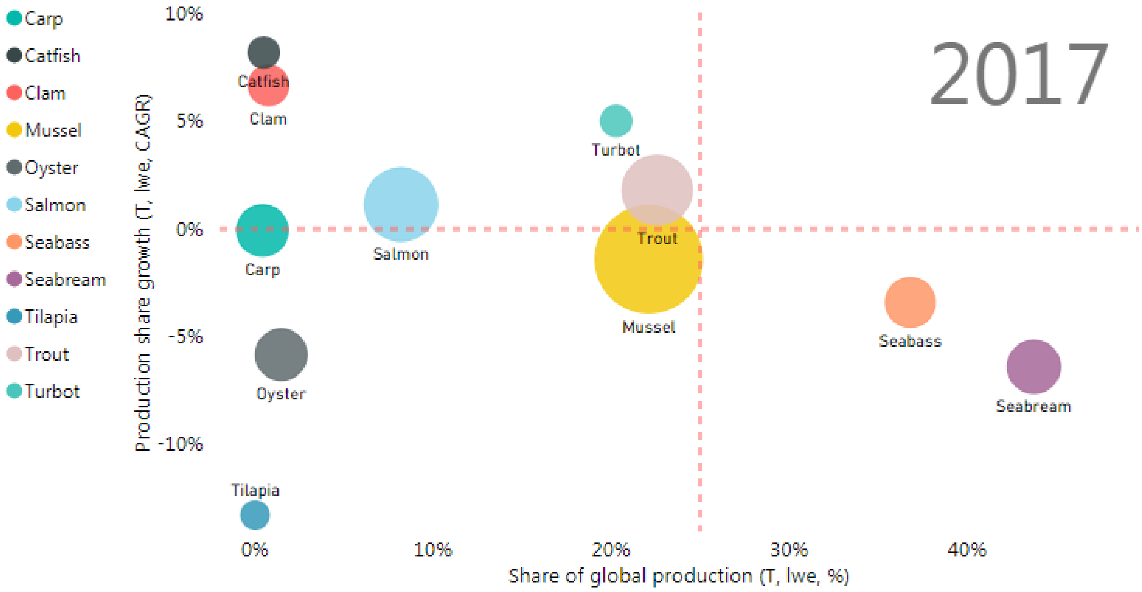
Figure 3-10. Export orientation of major EU seafood commodities, 2017

3.2.3.3 Market share

Positive growth in market share is a sign of competitiveness of an industry. Share is gained and competitive position is strengthened when the industry growth rate is higher than the world average.

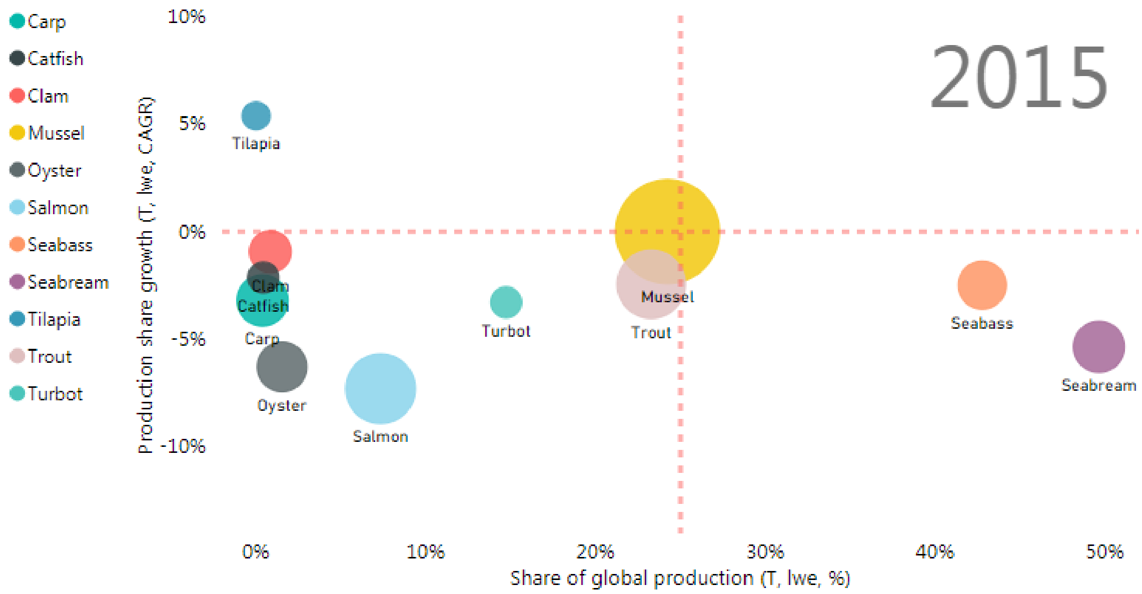
In 2017 EU produced Mussels, Trout and Turbot each represent (>20%) of the global production of these species, whereas Seabass and Seabream had a share of 35% and 45%, respectively (Figure 3-11). However, despite the production growth in EU Seabass and Seabream, their share of the global growth was negative, indicating faster growth in third countries. This trend has been sustained over preceding years as indicated in Figure 3-12, where it can be seen that in 2015, their share was higher by around 10%.

The production of Salmon, Carp and Mussels in the EU was growing at approximately the same rate as the global production for these commodities, while Clam and Catfish at a higher rate, gaining share, however from a low base. Turbot, despite a slight decline in EU production, improved its position due to faster decline in the rest of the world. Oysters and Tilapia production showed a worsening trend.



Bubble size indicates EU28 production by volume; horizontal axis is on a log-scale. CAGR – compound annual growth rate, based on three-year interval. Data source: FAO (2019)

Figure 3-11. Share of EU28 production in global production, 2017



Bubble size indicates EU28 production by volume; horizontal axis is on a log-scale. CAGR – compound annual growth rate, based on three-year interval. Data source: FAO (2019)

Figure 3-12. Share of EU28 production in global production, 2015

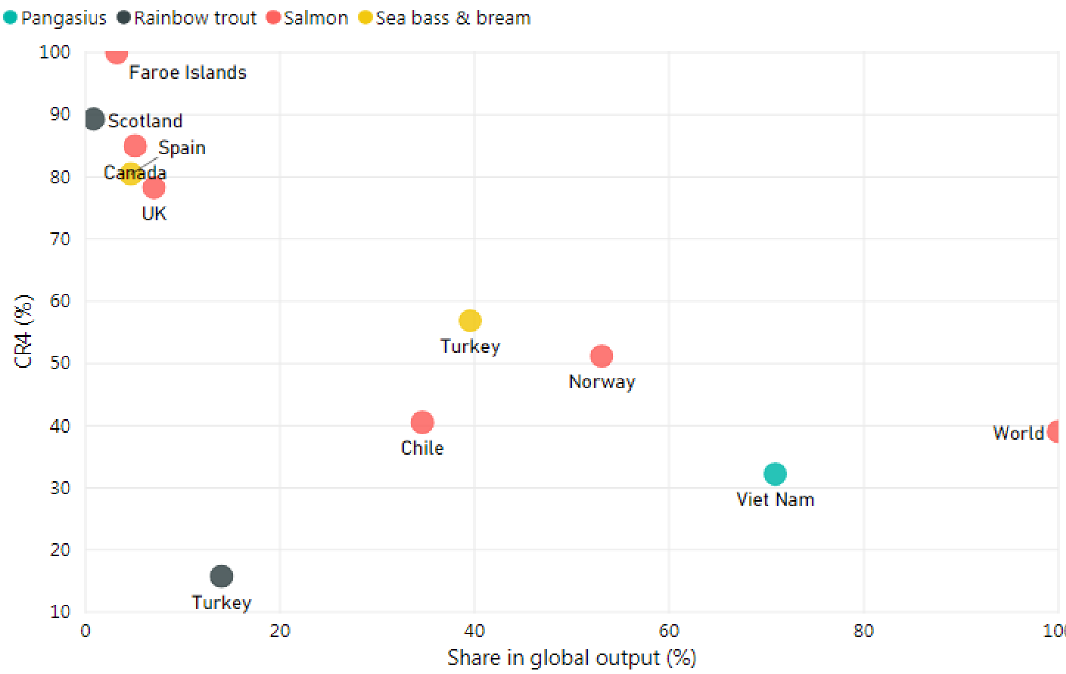
3.2.4 Production strengths and weaknesses

3.2.4.1 Industry concentration

An examination of the level of concentration in four of the selected industries in 2015 (Figure 3-13), for which company-level data could be obtained (see

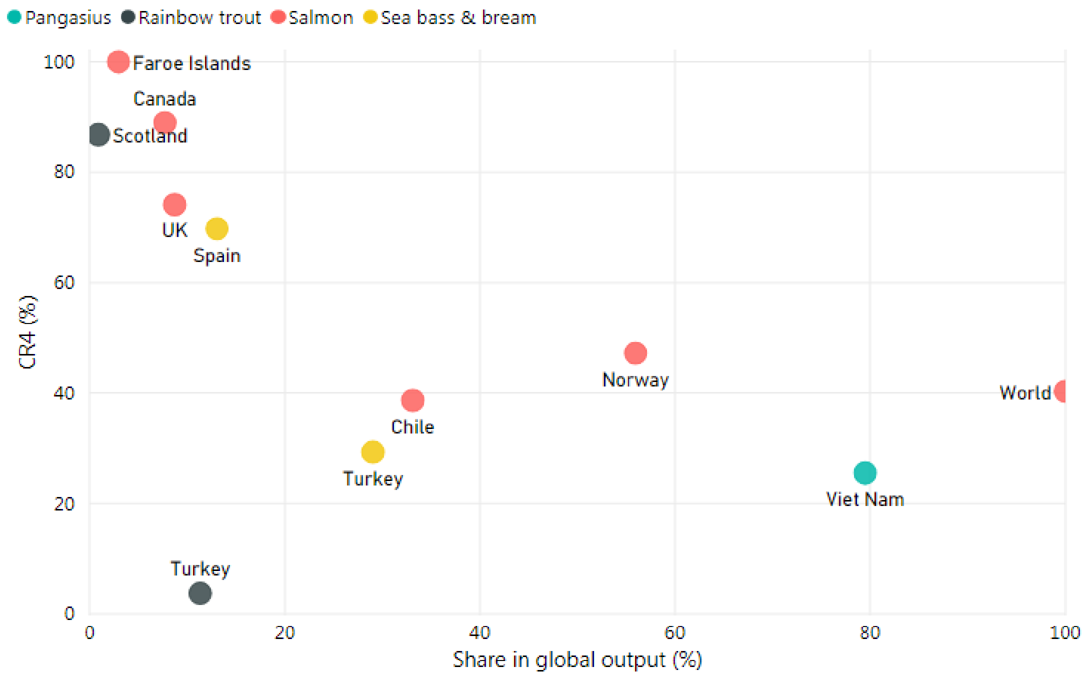
Table 2-4 in methods), reveals that within the salmon aquaculture industry Faroe Islands, Canada and the UK, while each having a small share in the global industry output, were the most highly concentrated with CR_4 ranging between 75% and 100%. Faroe Islands was the country with CR_4 of 100% since the industry consisted of only three companies. On the other hand, Norway and Chile, accounting for most farmed salmon output globally, had lower CR_4 of 52% and 42% respectively. Since salmon farming is an international business, with the same firms having operations in the different countries, the four largest salmon firms in the world controlled 40% of the global output.

A high level of concentration was found also in the Spanish sea bass and bream industry. The concentration in this industry had increased in both Spain and Turkey over the period 2010-2015, where in the case of Turkey it had almost doubled from 29% to 56% while in Spain it had risen by 10 percent points (Figure 3-14). An increase in the concentration of rainbow trout aquaculture in Turkey was also seen, although not to the same extent as for sea bass and bream. Rainbow trout production in Scotland (not including the rest of the UK) was highly concentrated too, with CR_4 close to 90%.



Data source: Orbis (2017), Republic of Turkey Ministry of Agriculture and Forestry (2017), Kontali Analyse (2018), The Scottish Government, (2018), VASEP (2018)

Figure 3-13. Extent of concentration (share of four largest firms in total industry sales, CR_4) in selected national aquaculture industries, 2015

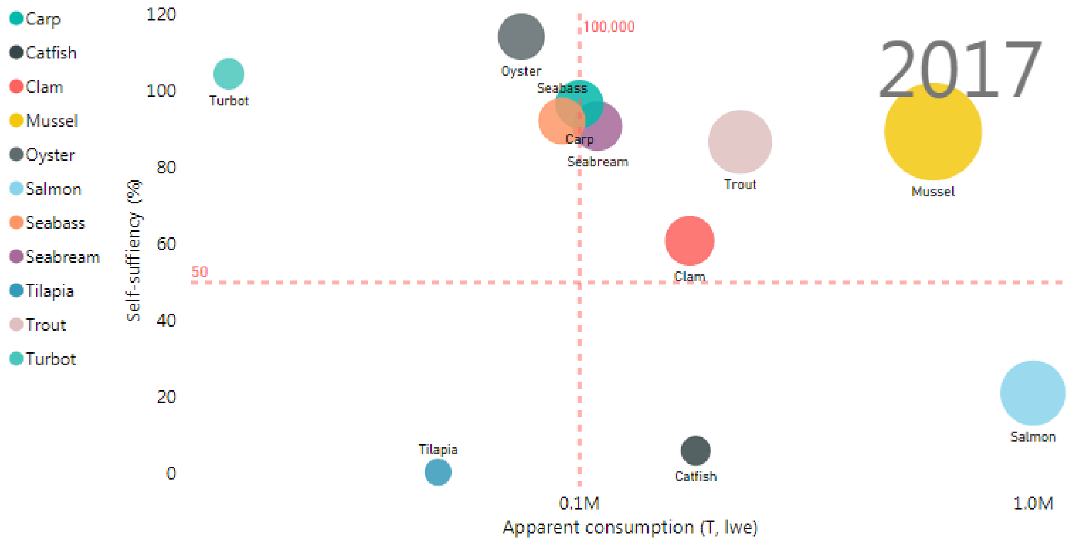


Data source: Orbis (2017), Republic of Turkey Ministry of Agriculture and Forestry (2017), Kontali Analyse (2018), The Scottish Government, (2018), VASEP (2018)

Figure 3-14. Extent of concentration (share of four largest firms in total industry sales, CR_4) in selected national aquaculture industries, 2010

3.2.4.2 Self-sufficiency

High self-sufficiency rates of more than 80% were found for many of the commercial species examined including Mussels, Trout, Clam, Seabream, Seabass and Carp, while Oysters and Turbot, showed even higher values of more than 100% indicating a positive trade balance for these commodities, Figure 3-15. Salmon and Catfish, on the other hand, for which there was high demand, had a low self-sufficiency rate of below 20%.

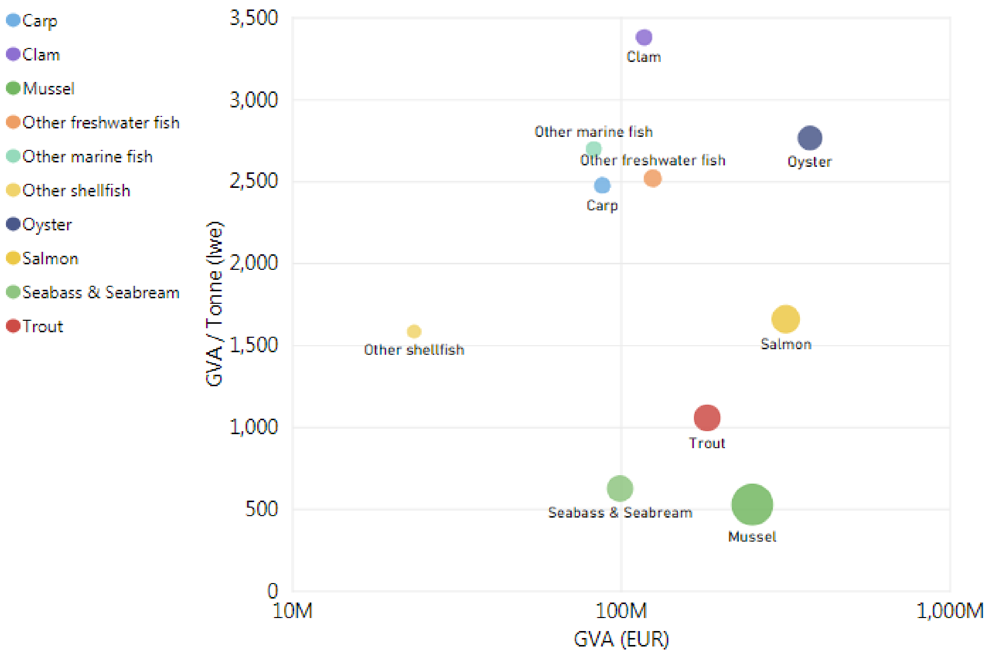


Bubble size indicates EU28 production by volume; horizontal axis is on a log-scale. Source: FAO (2019), EUROSTAT (2019)

Figure 3-15. Self-sufficiency for selected EU seafood market commodities, 2017

3.2.4.3 Productivity

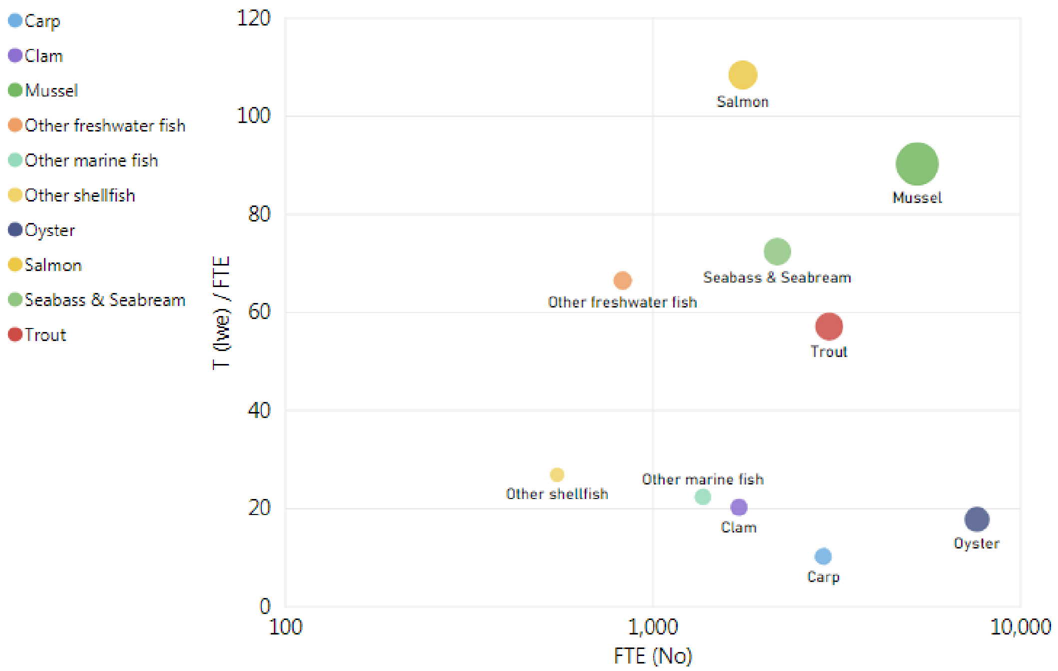
Figure 3-16 shows the GVA and productivity of the main EU aquaculture production systems. According to the figures provided by Member States, Oyster had the largest share in the total GVA for aquaculture, while Clam was the most productive category, followed by Oysters.



Bubble size represents total volume sales (T, lwe); horizontal axis is on a log-scale. Source: Nielsen, Carvalho and Guillen (2018)

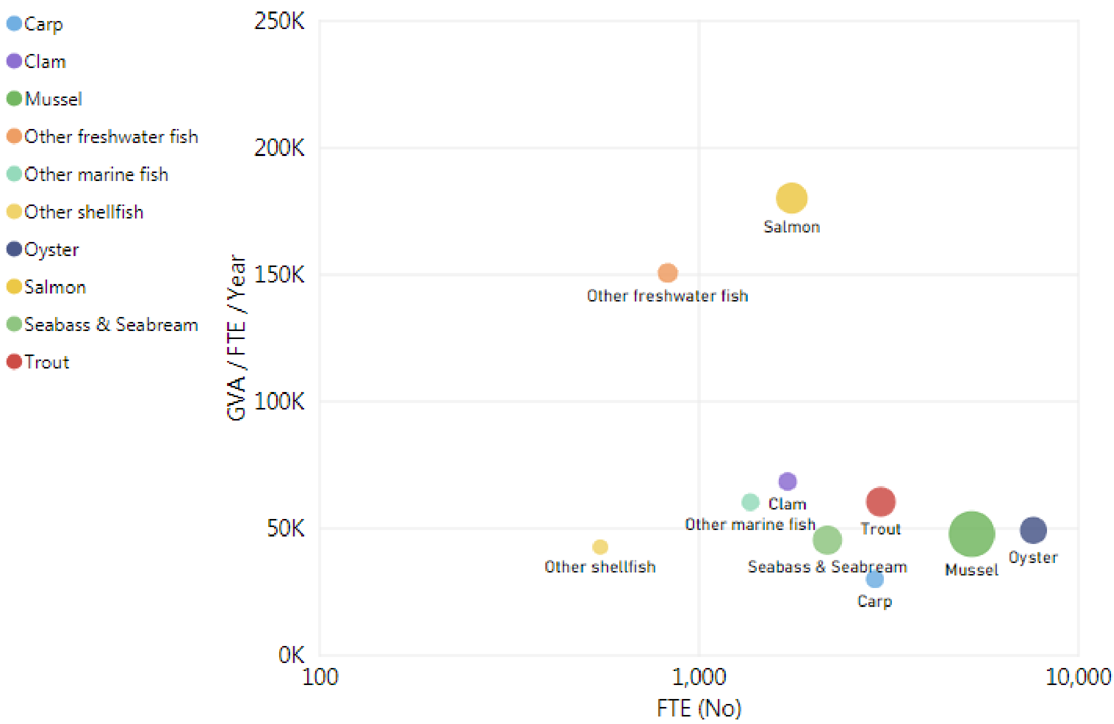
Figure 3-16. Gross value added (GVA) and productivity of EU aquaculture by commodity, 2014

Figure 3-17 shows the 2014 figures reported by member states on employment by industry and the calculated labour productivity expressed as Quantity output per FTE. The indicator establishes the relationship between quantity of output (the primary focus of the EU aquaculture growth goals targets) and the number of employees needed, which can be used to calculate the needed increase in the labour force if the targets are to be achieved with existing technology. The largest employer according to these data was the Oyster industry with 7,600 FTEs. Highest labour productivity was revealed for Salmon of less than 1 FTE per 100 tonnes produced, while the Carp industry had the lowest productivity of nearly 10 FTEs. The same observation was made for labour productivity in terms of GVA generated per FTE, Figure 3-18. The total reported number of employees for all species selected in 2014 was 27,688 FTE with an average productivity of 2.1 FTEs per 100 kg.



Bubble size represents total volume sales (T, lwe); horizontal axis is on a log-scale. Source: Nielsen, Carvalho and Guillen (2018)

Figure 3-17. Employment (FTE) and labour productivity per unit volume of output by industry for 2014



Bubble size represents total volume sales (T, lwe); horizontal axis is on a log-scale. Source: Nielsen, Carvalho and Guillen (2018)

Figure 3-18. Labour productivity (GVA/FTE) and Employment (FTE) by industry for 2014

3.3 Discussion

One of the main arguments for promoting aquaculture growth in the EU relates to the region's low self-sufficiency in seafood (European Commission, 2009b). Policies targeting an increase in seafood self-sufficiency emphasize expanding domestic aquaculture production since significant further growth is not anticipated to come from fisheries (Lopes *et al.*, 2017). However, the results presented above indicated that a large proportion (62% by volume, lwe) of the seafood consumed in the EU, whether imported or domestically produced, consisted of species that could not be produced in aquaculture but could only be supplied from capture fisheries. The implication of this finding is that if all 'aquaculturable' species consumed in the EU were produced in the EU (i.e. imports were substituted by domestic production), while maintaining the same market structure, seafood self-sufficiency would increase by an additional maximum of 28% (on the 10% that are already produced, to reach the maximum of 38%). However, this is unrealistic since the largest share is for cod, which although can be produced in aquaculture, is in direct competition with capture fisheries and is unlikely to see a major increase in output if the cost of production is not reduced or a sufficient level of differentiation from fisheries is reached (Frampton, 2007). However, changes in the availability of wild stocks and/or consumer preferences, might present an opportunity for a development of the cod aquaculture industry of a wider scale. The species is already established as a commodity and has a global market (Anderson, Asche and Garlock, 2018), however, it is supplied by fisheries and the few aquaculture companies producing cod that are in operation[9] supply cod as a niche product, which is by definition characterised by a small market. Similarly, shrimp and catfish production is largely confined to tropical and sub-tropical countries. Therefore, from a self-sufficiency perspective, the seafood market cannot be seen as a single food category which aquaculture can address uniformly but a more nuanced and targeted approach needs to be taken to the development of aquaculture in the EU. The results suggest that significant growth in EU aquaculture output could improve the balance of trade but is unlikely to provide a major solution to the self-sufficiency problem as long as the structure of seafood demand remains the same. There is little substitution between farmed and captured products (Asche, Bjørndal and Young, 2001). Thus, some of the increase in aquaculture output can match with local demand, however, global value chains will still be needed to ensure adequate and stable food supply (Kinnunen *et al.*, 2020). In the longer term, growth in the demand for locally produced seafood might expand the potential for incresing the share of local aquaculture in the total seafood consumption of the EU. There is consumer interest in 'locally' produced food which tends to be stronger when communicated clearly through trusted standards (Zander and Feucht, 2018). Nonetheless, according to the same authors, the fraction of consumers ready to pay a premium for these attributes is relatively small.

Salmon is the main commercial species imported into the EU market worth EUR 4.8 billion in 2018 (EUMOFA, 2019c). With high global demand and low self-sufficiency rate, it presents an attractive market segment. However, major expansion in the salmon industry in the EU is highly unlikely in the short-term because of lack of suitable marine farming sites (Hofherr, Natale and Trujillo, 2015; Lopes *et al.*, 2017). However, the large market for Salmon created by imports presents opportunities for the development of limited amount of local production close to end consumers. The use of land-based systems (RAS) could provide means for servicing the high-end niche markets in urban areas, provided premium price is achieved to justify the high capital and operational costs of this type of system (Song *et al.*, 2019). Nevertheless, significant growth in production and closing the self-sufficiency gap cannot be expected to come from such development while the highly efficient net pen systems dominate production in third countries and global trade continues. Potential for expansion in EU output in the long term exists in the use of novel technology for off-shore farming (Bostock *et al.*, 2016). On the other hand,

[9] E.g. Norcod (www.norcod.no)

economic benefits to the EU can also come from increasing the extent of value addition to imported or locally produced raw material. The primary objectives of value-added product development is to create new markets for industries that may have shown stagnant growth (Cooper and Kleinschmidt, 2007). While Salmon has a relatively high range of value-added products compared to other seafood commodities, there is still unutilised potential, especially compared to other animal protein sources such as chicken (Asche, Cojocaru and Roth, 2018). The poultry industry has done extremely well in satisfying consumer demand and the variety of poultry products (from just a few species) that are offered to the consumer is astonishing (Morrissey and DeWitt, 2014). Differentiation in farmed salmon instead remains rather limited, as it lacks the product diversity and the flexibility in the farming node of the value chain (Cojocaru, Iversen and Tveterås, 2020). The route to economic growth through value addition is the topic of Chapter 6 of this dissertation.

Since Norway, the primary source of salmon to the EU market, is part of the European Economic Area (EEA), it trades freely with the Union and usually no tariff measures apply for imports from Norway. Also, common rules and equal conditions of competition exist between the two parties. In the cases of mergers of companies in the two jurisdictions, the Commission has exclusive right to deal with anti-competitive behaviour affecting the Community (European Commission, 2014a). An illustration of this was the acquisition of Morpol (an EU based company) by Marine Harvest (Norwegian) and the associated requirement by the EC for divestment of production facilities because of concentration concerns (European Commission, 2013a). While the growth of the salmon industry has been accompanied by global consolidation (Asche *et al.*, 2013), the extreme level of consolidation reached in the Faroe Islands cannot be reached in the UK due to competition law because of which concentration appears to have stabilised at around 80%.

Trade with Turkey, on the other hand, which is also a main EU trading partner in seafood, particularly in the import of trout, sea bass and sea bream, while part of the European Union Customs Union (EUCU), can be regulated by the application of tariff duties. Such measures have been used in the case of rainbow trout imports, where countervailing duties as high as 9.5% have been applied to trout products in response to EU producers' complaints of unfair competition due to trade-distorting state subsidies (European Commission, 2020a). Thus, the analysis indicates that a more useful boundary for further competitive analysis of the seafood sector in the EU may not be the EU itself but the EEA, since EEA members are part of the Single market, whereas protection measures can be more easily applied to countries outside of it. If the boundary is extended to include the countries of the EEA, the issue of the lack of growth in aquaculture would largely become irrelevant with the addition of Norway, and the question would transform into how to achieve more equal distribution of production across the area, to bring economic benefit to wider territory and range of stakeholders. Equally, the removal of the UK from the analysis, in the case that the UK exits the Single market, would exacerbate the self-sufficiency and balance of trade problem and would call for a stronger growth stimulus in the remaining area if these issues are to be addressed.

The results have shown that for many of the main aquaculture species produced in the EU, especially shellfish, sea bass, sea bass, sea bream, carp and trout, self-sufficiency rates were already high or exceeding 100%. Increasing the production of commodities with high self-sufficiency rates, while targeting the same markets and not differentiating from imports, carries the risk of overproduction and price crashes. Although the causes of boom-and-bust cycles that are observed in aquaculture are many and complex, including economic, social and biological, overproduction is one of the main factors (You and Hedgecock, 2019). Therefore, growth in the production of these species needs to be accompanied by the development of export markets and domestic demand e.g. through market penetration and new product development strategies. Thus, strategy development needs to take into account not only which aquaculture sub-sectors to prioritise and their and locations but also at which stage of the value chain interventions are most necessary, in an overall market-orientation approach (Grunert, Trondsen and Young, 2010).

For example, most member states have the factors necessary for trout production, and thus, growth policies targeting the trout industry can benefit a larger number of member states compared to other forms of aquaculture. However, a threat to the growth of the industry is the static demand for trout, partucularly plate-size fish. Moreover, the demand for predominantly portion-size trout is more fragmented than larger salmonids and formed by a number of smaller size markets, corresponding to the main attributes imparted on the product by the different methods of farming and preservation – e.g. large vs. plate size; pink flesh vs. white flesh, fresh vs frozen – each of which is exposed to its own demand structure. Nielsen (2011) finds that when portion size trout with white flesh was sold fresh on the German market, it had a price elasticity of -1.0, i.e. a 1% increase in imports would lead to a 1% price reduction, although the option of selling frozen instead of fresh provides an option of price stability for producers (Nielsen *et al.*, 2011). Strategies of productivity growth and associated cost reduction have been exemplified by larger farms in Denmark which maintain competitive advantage due to economies of scale and closeness to high value markets (Lasner *et al.*, 2017). On the other hand, Turkish farms benefit from competitive advantages due to low labour cost and favourable climate conditions (Lasner *et al.*, 2017), as well as governmental subsidies (European Commission, 2020a) and not necessarily high productivity (Cinemre *et al.*, 2006). However, as the results on industry concentration have indicated some productivity gains may have been achieved with increasing consolidation in the Turkish trout industry in the past decade. While high concentration was also observed in Scotland the industry in other EU states is composed predominantly of small-scale traditional farms, which, in the context of Turkey's advantage as a low-cost producer (Lasner *et al.*, 2017), are unlikely to compete successfully on price, which suggests the need for a differentiation strategy and targeted stimulation of demand for the attributes along which products are differentiated.

The EU holds a major share in the global production of Seabass and Seabream and the sector is one of the main strengths of the aquaculture industry in the region. Production is concentrated in Mediterranean states, dominated by Greece who is a main EU supplier for the region (EUMOFA, 2019c). High share in global production is an indication that factors exist which give comparative advantage for the production of the commodity in the EU. However, faster growth in Turkey, which benefits from lower production costs, and rapid concentration, and increasing imports into the EU challenge the competitive position the industry. To maintain competitiveness in the large but undifferentiated fresh products market, the EU seabass and seabream aquaculture needs to improve productivity. Productivity improvements can be expected since the industry is in a phase of consolidation, in Spain as the results have indicated, but also in Greece (FAO, 2020). However, segmenting the market by developing new products needs to be pursued in parallel to create additional demand through which to reduce the risk of overproduction and bust cycles (FAO, 2019a) and accommodate production increases. Such development can come from the farming of larger size fish which provide greater opportunities for value addition than the dominant size of < 500 g and the production of which has begun (Asche and Bjørndal, 2011). Since trade remains regional, the development of third country export markets is a further opportunity for growth.

In the case of Carp, with little international demand for this species, production growth will need to be accompanied with strategies for expanding demand on the domestic markets. Investment decisions need to focus on expanding existing markets, where there is tradition in the consumption of carp. The creation of additional demand locally and within the region can be pursued using penetration and new product development strategies for example through value addition aimed at overcoming fundamental product attribute issues (e.g. intra-muscular bones, off-taste). The development of boneless convenience products for enhancing the consumer acceptability of the carps has been proposed as a promising route to increasing consumption (Sehgal and Sehgal, 2002; Bochi *et al.*, 2008). The opportunity needs to be explored further, particularly in combination with differentiation strategies exploiting current market trends such as environmental sustainability, local origin etc., in order to differentiate the offerings from imports of generic white fish flesh such as pangasius, while limiting price competition between rival domestic producers. Development of value-added products may increase access to modern retail channels and increase regional trade (Grunert and van Trijp, 2014). The development of effective producer organisations can play a vital role in this process. The results have indicated that there is scope for cost reduction, such as improving labour productivity through mechanisation (labour productivity for Carp was the lowest amongst the species groups examined). The risks to growth without demand stimulation and market expansion include intensified competition between domestic producers and profitability erosion. A review of communication campaigns on aquaculture in the EU by European Commission (2014) concluded that at the background of a lack of general awareness of aquaculture, the promotional campaigns consider aquaculture as a unified sector and not exploring the opportunities that its diversified products and methods of production provide. In order to promote concrete products against the competition, there is a need for a movement from generic messages to clearly segmented commercial and promotional strategies, similar to more established farming sectors such as the poultry industry (Asche, Cojocaru and Roth, 2018).

The production and consumption of oysters in the EU in 2017 was dominated by France, a gloabal leader in this industry and a net exporter to other member states. However, Oyster consumption in the EU showed an overall negative trend in the period 2015-2017, primarily due to a viral disease outbreak in France (EUMOFA, 2019b). While official statistics by FAO (2019) showed an annual production of 65,000 tonnes in 2017, output has likely increased in the past two years as industry sources claim production of over 100,000 for France alone in 2019 (personal communication). Further production expansion needs to be associated with demand stimulation, which may come from market penetration of regional market for example through marketing efforts targeting an increase in the occasions on which oysters are consumed (consumption tends to be seasonal); exploiting new non-traditional but fast-growing markets in the EU such as Germany, Bulgaria, Sweden, Austria. Stimulation of demand and stabilisation of sales throughout the year can also come from increasing the share of value added and long-shelf life products such as canned and smoked oysters. While trade with Mussels was mostly limited to within the EU, expansion of demand could be achieved through increasing differentiation from imports e.g. by the development and promotion of value-added products bases on mussels (Scott *et al.*, 2010).

In the case of Turbot, production growth needs to focus on penetrating the markets of other EU states, as well as seek opportunities for increasing and consolidating exports to third countries. The production increase has to be accompanied with innovation to reduce costs of production in order to make the species more affordable for consumers and increase market demand. Since production systems are land based, the scope for reducing cost through economies of scale is not as high as for marine net pens, however, limiting the extent to which Turbot can become a widespread commodity (Bjørndal and Øiestad, 2011).

A central aim of the study was to provide a more nuanced understanding of seafood and aquaculture in order to assist with the development of tailored aquaculture policies to growth. First, the analysis here has shown that while the EU did not exhibit revealed comparative advantage for seafood as a whole, performance varies between industries and counties in the pattern of specialisation, which point to the industries with comparative advantages for particular species and locations.

Where RCA is below 0 this does not mean that comparative advantage does not exist in the production of seafood in the EU or there is no potential for it to be developed, but rather, that it cannot be 'revealed' through the current patterns of specialisation in exports. Thus, the result should not be interpreted as evidence for diversion of resources away from the seafood industry but indicate which industries are already exploiting comparative advantages. Moreover, further investigation is required to estimate the actual comparative advantage, by using measures such as Domestic Resource Cost (DRC), provided more data is available (Cai, Leung and Hishamunda, 2009). DRC analysis, which measures a country's efficiency in domestic resource utilization in the production of certain goods requires detailed input costs data disaggregated by origin (domestic and foreign) and the estimation of 'shadow prices', which purge market prices from policy and other distortions and hence provide a measure of the true or social value of production costs and revenues. As such, the analysis is appealing with its direct policy implication but suffers from the lack of quality data on production costs (Cai, Leung and Hishamunda, 2009). If such data are available, the DRC approach may be preferred to indicate actual comparative advantage, but The RCA index remains useful in monitoring the year-on-year change in the patterns of specialisation, as a proxy measure of the comparative advantage in an activity.

A targeted approach to the development of aquaculture can also lead to marked differences in economic impact. As the analysis of GVA indicates in Figure 3-16, there is variability in economic contribution between aquaculture sectors. *Inter-alia*, an increase of aquaculture production by 25% (which was the projected figure according to national level strategies) over the total production for 2014 (1,250,000 tonnes) could be expected to directly create a further 6562 jobs (assuming proportional growth across species), while adding EUR 382 million of GVA to the economy (assuming average productivity of 61,000 EUR/FTE). However, an increase in the economic contribution of aquaculture can be achieved more easily if expansion policies target the species and systems with higher impact potential i.e. higher productivity. An increase by one tonne in the production of mussels will lead to GVA growth of EUR 530 while the same increase in the production of Oysters would add EUR 2,700 to the economy.

International organisations created to coordinate development of aquaculture across countries in Europe include The General Fisheries Commission for the Mediterranean (GFCM) whose mandate is to federate the sustainable development of aquaculture and the conservation and sustainable use of living marine resources at all levels (biological, social, economic and environmental). Similarly, a regional organisation with a mandate to aid in the development of aquaculture is the Network of Aquaculture Centres in Central and Eastern Europe (NACEE). While the GFCM has a strategy for the development of aquaculture, it consists of general guidelines and principles (FAO, 2018a). It could be enhanced by disaggregating aquaculture to systems and species levels and provide a direction to the development of particular sectors, working alongside national governments to ensure coordinated aquaculture development efforts in the region.

3.4 Conclusions

This study has identified a set of indicators based on publicly available data to compare across of commodities and member states and has indicated priorities for support for aquaculture development. The results indicate that a large proportion (62%) of the EU seafood market, whether imported or domestically produced, consisted of species that could not be produced in aquaculture, which carries implications for policies promoting aquaculture growth as means to seafood self-sufficiency. Further, the results reveal the heterogeneity in performance between sectors and countries along various dimensions and maintains that a nuanced and targeted approach needs to be taken to the development of aquaculture policy. In order to ensure economic sustainability of interventions, adopting a market-orientation approach and considering how markets will absorb additional output when targeting sectoral expansion was emphasised. For the commodities that comprise a relative large market segment, such as

Seabass, Seabream, focus needs to be given on strengthening competitive advantage against competitors and pursuing a leadership position through upgrading and development of strong third-country export markets, in addition to developing additional domestic and regional demand through product innovation and market penetration. For the commodities with high self-sufficiency but no global market access, such as Carp and bivalves, regional market development through product line extension and market penetration is more appropriate.

Chapter 4: The determinants of international competitiveness: a comparative case study of salmonid aquaculture in the UK

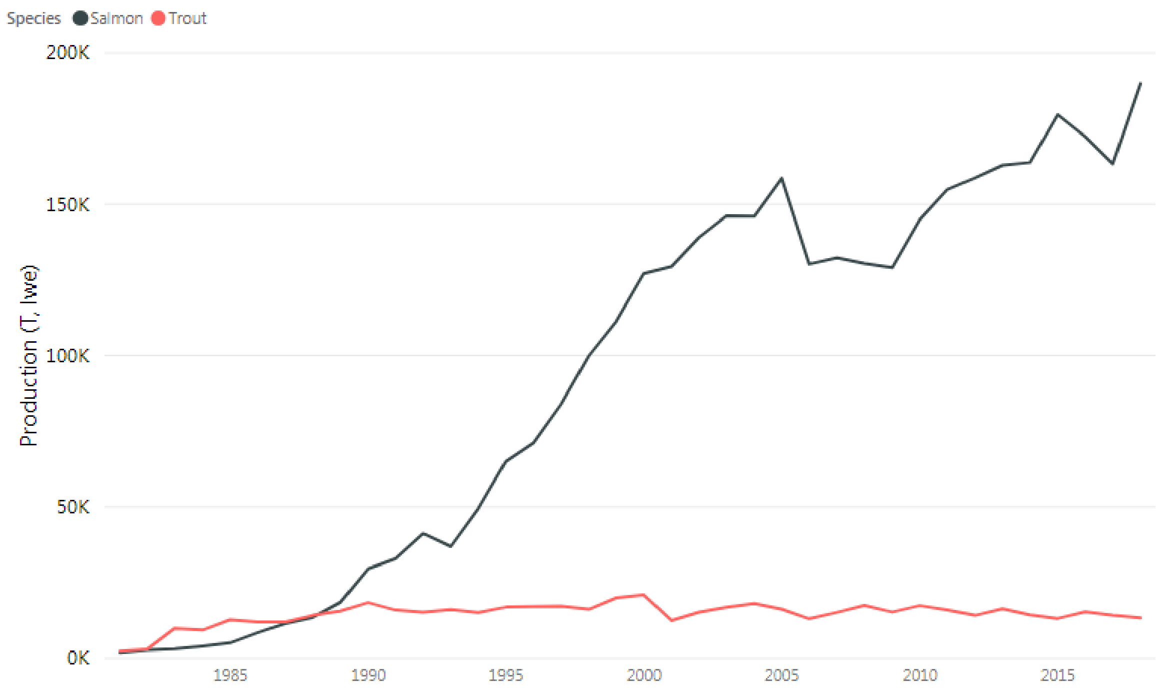
4.1 Introduction

After having examined the performance of the aquaculture sector at EU level based on a range of economic metrics, this study aimed to investigate the underlying factors that determine the different competitive and growth outcomes in aquaculture at the industry level. To this end, a comparative case study of the Atlantic salmon and rainbow trout industries in the UK was developed as an example of two industries with contrasting competitive outcomes within the same country. Understanding of these factors can be applied in the formulation of more effective policies to support aquaculture development, in the UK and other contexts.

Salmon aquaculture has shown a phenomenal growth rate since its emergence in the 1970s (Nash, 2011) and is currently regarded as the most mature form of large scale aquaculture and represents a globally traded commodity (Asche *et al*., 2013). The industry is considered the benchmark of fish farming practices (Asche, 2008; Asche and Smith, 2018). On the other hand, rainbow trout aquaculture, being a pioneer industry in modern aquaculture, has plateaued and is currently in decline accross all EU countries. In contrast, its production in Turkey has „exploded" over the last decade and the country now serves as a major supplier of rainbow trout to the EU (Lasner *et al.*, 2017). The case of rainbow trout illustrates the situation for most other freshwater species traditionally produced in the EU, such as carp. A detailed analysis of the salmonid sector in the EU covering the commercial species Salmon and Trout, disaggregated by member state and main competitors, developed by applying the tools in the benchmarking platform described in the preceding two chapters, can be found in Appendix 3: The salmonid sector, while additional competitiveness-related data on other species in Appendix 4: Commercial species profiles.

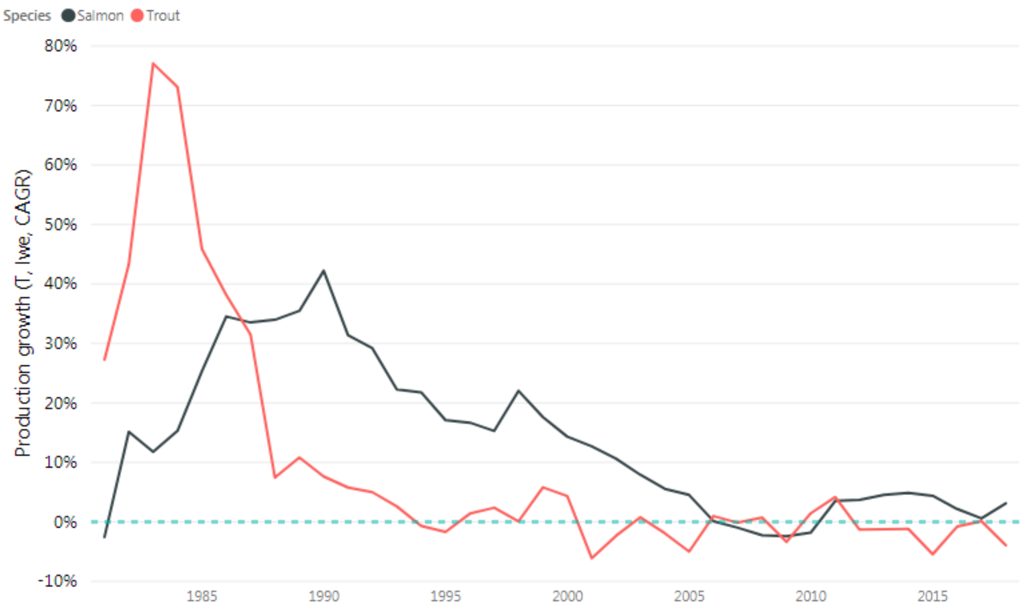
4.2 Results

Rainbow trout farming for the table the UK has emerged as an industry earlier than the salmon aquaculture, in the 1950's. The main production system used from the beginning has been earthen ponds and raceways. Prior to the establishment of salmon aquaculture, there have been attempts in both the UK and Norway to grow rainbow trout in marine net pens, however, these were quickly replaced by Atlantic salmon when the technology for transferring salmon smolts was established, due to the higher market price for salmon (Nash, 2011). This was followed by rapid growth of Atlantic salmon farming in Scotland in the late 1970s and early ‘80s. UK trout farming quickly plateaued and since the mid-1990s as been stable at around 12,000 to 16,000 tonnes annual production (Figure 4-1), in contrast with salmon aquaculture and global aquaculture growth the 1990s and 2000s (Hambrey and Evans, 2016). While the growth rate of the salmon industry had also slowed down in later years, it was still higher than that of trout (Figure 4-2).



Data Source: FAO (2019)

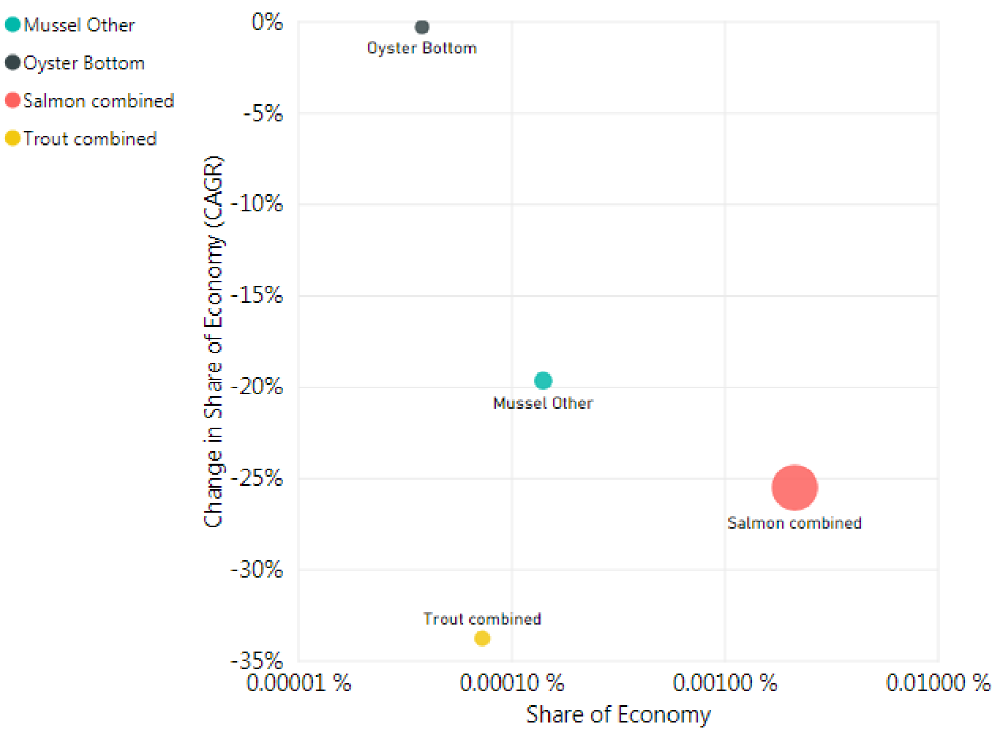
Figure 4-1. UK salmon and trout production volume, 1980-2017



Data Source: FAO (2019)

Figure 4-2. Growth rates of UK salmon and trout production (T lwe), 1980-2017

The different growth patterns of the two industries have translated into a markedly higher contribution to the national economy of salmon compared to trout (Figure 4-3).



Data source: STECF (2016)

Figure 4-3. Share of economy and as measured by GVA and annual change in the share of economy by aquaculture industry in the UK, 2014

4.2.1 Demand for salmon and trout in the UK

UK seafood demand is largely limited to the „big five“ – salmon, tuna, shrimp, cod, haddock, which comprise 60-75% of the seafood eaten in the UK (different sources give different estimates), while trout represents a small franction of the remaining 25-40%. Figure 4-4 shows the demand for salmon and trout by EU member state. Whereas the UK was one of the largest markets for salmon, and per capita consumption was higher than the EU average for this commodity, it was the opposite for trout, with per capita consumption lower than the EU average. The difference in per capita consumption between salmon and trout in the EU also stands out.

Source: UN Comtrade, (2018); FAO (2019); The World Bank (2019)

Figure 4-4. Demand for salmon and trout by member state in 2017

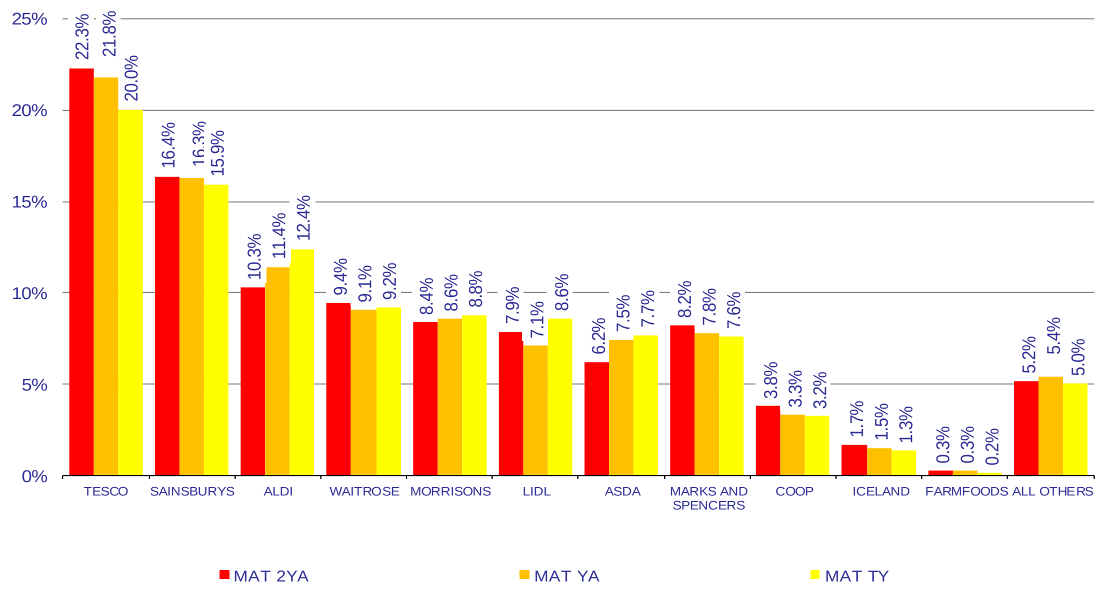
Demand determines the extent to which it is worthwhile to increase salmon supplies (Shaw and Muir, 1987). According to Asche *et al.* (2011) demand growth has been an important factor in the increase in salmon production since the late 1990s. The authors report that demand growth has been 7.6% per year for the EU and 4.7% for France, on average. More recent demand estimates for established markets, such as the United States and Japan and Europe, demonstrate lower annual demand growth, at approximately 3% over the period 2002–2011, while the average annual rate of aggregated global demand was approximately 9% (Brækkan and Thyholdt, 2014). The growth in demand has been attributed to reduced prices (Asche and Bjørndal, 2011), new product development (Cojocaru, Iversen and Tveterås, 2020), new distribution channels and sales outlets (Guillotreau, 2004). Moreover, exports of aquaculture products from Norway increase with the targeted country's wealth level (Straume *et al.*, 2020). Unidentified factors contribute to more than half of global salmon demand growth in recent years highlighting the inability to explain demand growth only by principal economic factors (Brækkan *et al.*, 2018). Aquaculture products are influenced by more factors than fisheries products, such as transportation costs and per-unit shipment costs, indicating dimensions where efforts can be focused to further improve competitiveness (Straume *et al.*, 2020). Demand analyses of indicate that salmon products are not chosen as substitutes for one specific product, but have instead taken small market shares from a large number of products (Asche and Bjørndal, 2011), amongst which is marine grown trout (Landazuri-Tveteraas *et al.*, 2020).

The domestic UK seafood market can be broadly divided into retail chains and food service. Salmon and trout products reach the consumer mainly through the retail channel. Salmon is the number one consumed species in the UK in terms of value and volume of sales (amounting to £914 million and 50 thousand tonnes net weight) realized through multiple retail chains or about 30% of the value of all fish sales through this channel (Seafish, 2020). Of the total value of salmon sales, £289 million (31%) were smoked salmon products.

On the other hand, the UK retail market for trout is relatively under-developed. The total sales of trout through multiple retailers in the UK amounted to £38 million per year (corresponding to net volume of about 3000 t) at the end of 2019, accounting for around 75% of UK trout production and 1% of total seafood sales (Hambrey and Evans, 2016). There is a low variety of trout-based products, most sales are of chilled whole fish and fillets at the fresh fish counters of major retail chains. Of the total value of trout sales, £8.4 million (or 22%) was generated by smoked trout products. Smoked trout is a niche product and is not widely available in the UK retail market. Upmarket retailers (Waitrose and Sainsbury's) account for the largest share of smoked trout sales (Seafish, 2020).

The success of multiple retail chains, which is related to economies of scale and consumer demand for convenience shopping, has precipitated the decline of specialist outlets in all food categories, including fishmongers. Concentration ratios reveal the scale of change that has occurred in fish sales. In 1988, the five largest supermarket chains accounted for only 31.5% of total fresh fish sales, but by 1995 their share had increased to 60.9% (Murray and Fofana, 2002).

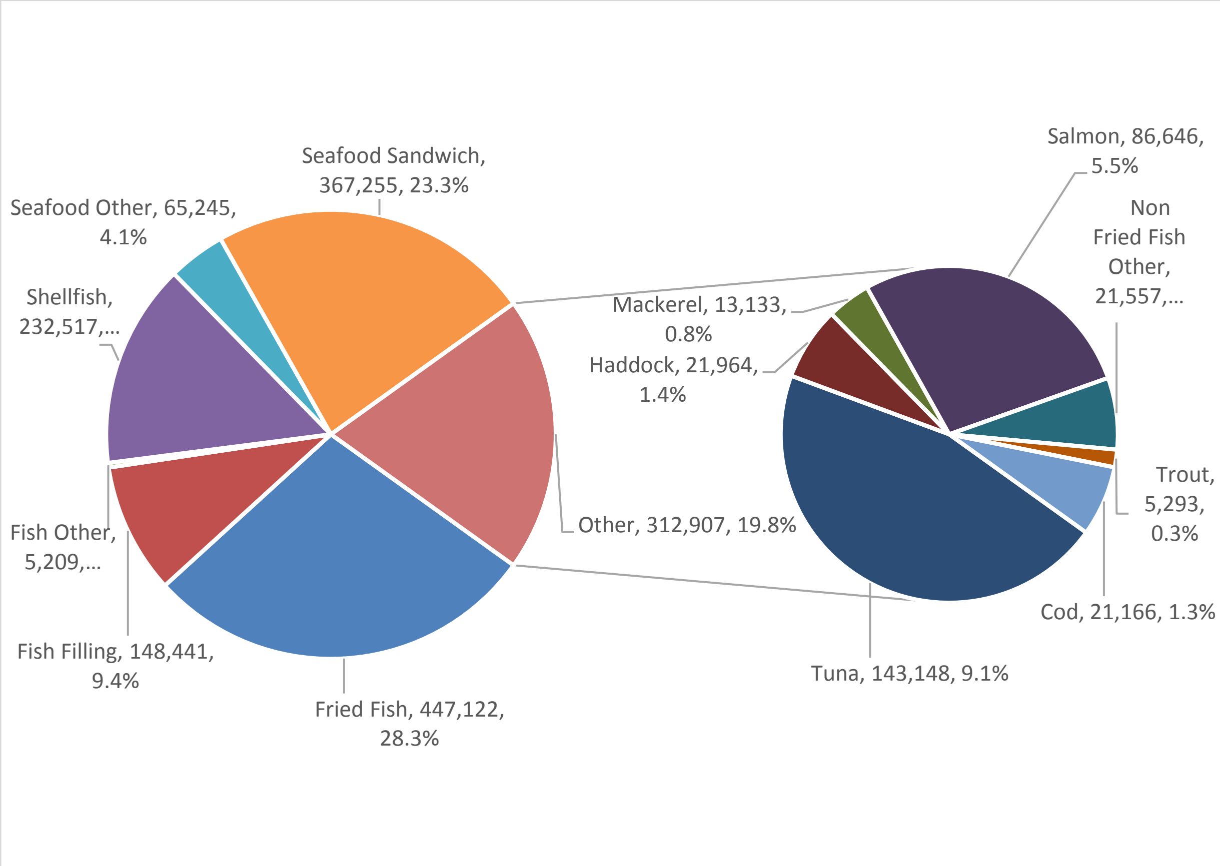
In 2019, Tesco alone had the highest market share amounting to 20% of total salmon sales, while the top five retailers accounted for more than 66% of the sales (Figure 4-5).



MAT = Moving annual total, YA = Year ago, TY = This year. Source: HomeScan (28/12/2019) / (Seafish, 2020)

Figure 4-5. Total salmon sales (value) by multiple retail chain in 2019

Furthermore, UK demand has shifted from whole 'plate size' fish, which is how traditionally trout has been marketed, to filets and fillet portions. A wide variety of salmon-based products exist in multiple retail chains, in fresh, frozen, smoked and value-added variants (Asche, Dahl, *et al.*, 2011). With little potential for processing compared to larger salmon, most trout are marketed whole round or gutted (James et al. 2011) linking the sector directly to the retail node of the value chain while largely limiting trout sales to the fresh fish counters. These have replaced the traditional fishmonger shops and become the main outlet for fresh trout products in the UK, however, fresh fish counters in multiple retailers are also declining in numbers. In 2020 the retailer Asda planned to replace many of its in-store fish and meat counters with its new ready-to-eat "Food for Now" concept. This move has followed a similar decision by Tesco to close some of their service counters including fish. Thus, the outlets for trout are continuing to shrink (Seafish, 2020).



Data source: Seafish (2020)

Figure 4-6. Out-of-home seafood consumption (servings, '000) in the UK, 2019

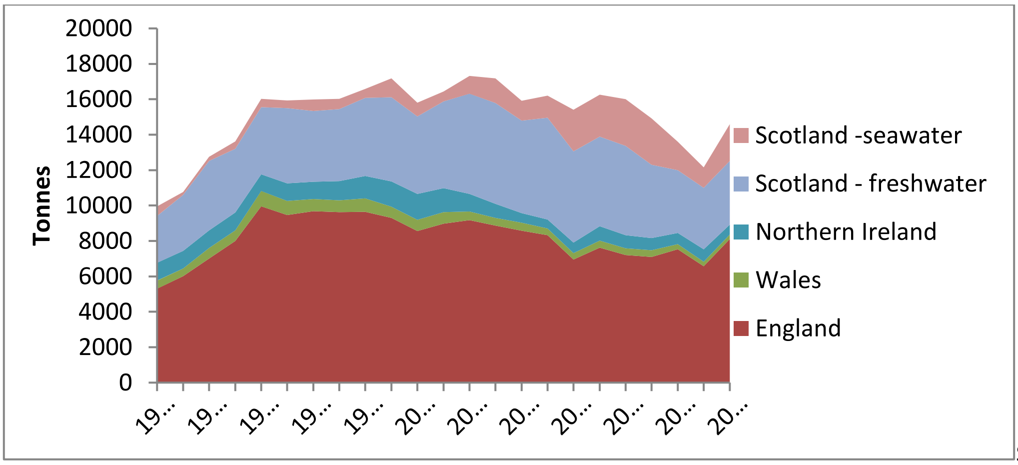
In 2019, the total UK number of out-of-home salmon servings reached nearly 87 million. On the other hand, it was estimated by Seafish (2020) that just 5.3 million trout dishes in total were served across the UK in 2019, or 0.3 % of the total out-of-home seafood consumption, Figure 4-6. The majority of those were served in hotels (travel and leisure); pubs and restaurants.

The UK is the only major producer of Atlantic salmon serving a large domestic market. Nonetheless, exports constitute around half of total output. Thus, the industry is attuned to the demand of foreign markets, too. A particularly important export market is France (Asche and Sebulonsen, 1998; Asche, Dahl, *et al.*, 2011). Asche, Jaffry and Hartmann (2007) find a high degree of price transmission in both supply chains, as well as integrated markets for the supply chains for salmon originating in Norway and the United Kingdom and is then sold at retail level in France as smoked salmon. Direct competition between country producers is not the only effect of market integration. On the positive side, research by Kinnucan and Myrland (2003) and Kinnucan and Myrland (2002) has shown that the advertising efforts of Norway have benefitted the UK exporters because of the generic nature of the exported product and the of the advertising campaign. In the case of trout, since most production is fragmented and small-scale, marketing also tends to remain local (James *et al.*, 2011).

4.2.2 Supply conditions

The global production of salmonid species in open systems is limited by climatic conditions and the availability of suitable aquatic resources to only a small number of countries. Although accounting for 7.1% of the global supply of Atlantic salmon, the UK is one of the few countries possessing the natural resource endowments for the production of this species in the highly productive marine net-cages systems. Unlike Atlantic salmon, rainbow trout can be grown to a marketable size in both freshwater and marine environments. Thus, the biological differences between these species, determine their dependence on different types of aquatic resources.

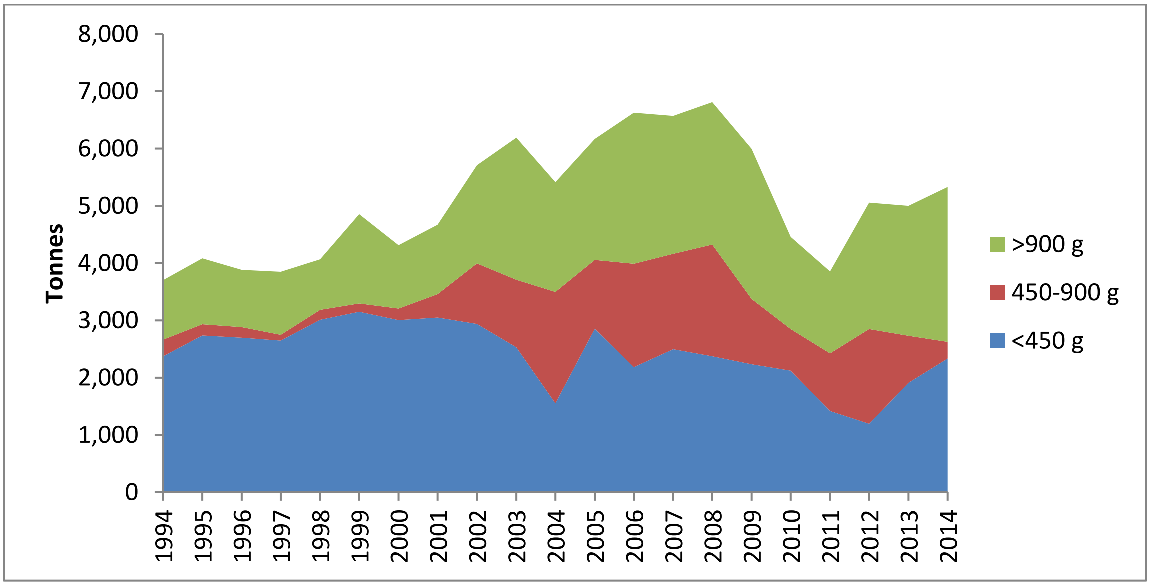
In the UK, rainbow trout is produced in both marine and freshwater environments (Figure 4-7). Most of the fish is produced in freshwater ponds, raceways, cages and tanks with a relatively small quantity farmed in sea cages. Only Scotland reports production of seawater grown rainbow trout, where the decline in production from freshwater has been partially offset by increased production from seawater. However, the availability of marine sites is the limiting factor to the expansion of marine fin-fish aquaculture (Hofherr, Natale and Trujillo, 2015; Asche and Smith, 2018). Most available sites are occupied by the much larger and better-resourced Atlantic salmon producing companies. Demand for new sites is high and the few existing rainbow trout cage sites in the UK tend to be the ones that are unsuitable for salmon. Thus, rainbow trout is in competition with salmon not just on the market for salmonids but also for production factors.



Source: CEFAS (2018), Marine Scotland (2018)

Figure 4-7. Rainbow trout production in the UK by region

Availability of natural resources for production has major implications for the structure of the UK trout industry. First, the type of system imposes a limitation of the form of the product that can be produced. Many types of intensive land-based aquaculture systems, such as those employed to produce rainbow trout, are operating most efficiently and have higher turnover, when growing fish to a relatively small size (Asche and Bjørndal, 2011). Large size fish demand larger volumes of water and are produced more cost-effectively in marine cages. Rainbow trout grown on land are typically harvested at a size of 200-500 g, whereas marine-grown rainbow trout and salmon are typically harvested when reaching of 3-5kg in size. Thus, the nature and access to aquatic resources and farming technology determines the characteristics of the 'raw material', which in turn determines the market segments on which the products derived from it are marketed. In other words, the land-based portion size fish sector remains production oriented rather than market driven. As previously indicated demand for portion size pink fish and products thereof is not high and not growing on the domestic market. Portion size (<450g) rainbow trout production in Scotland has been stable while an increase in the production of larger size trout (>900g) has accounted for the overall total increase in trout production in the country (Figure 4-8), which however is the result of marine farming.

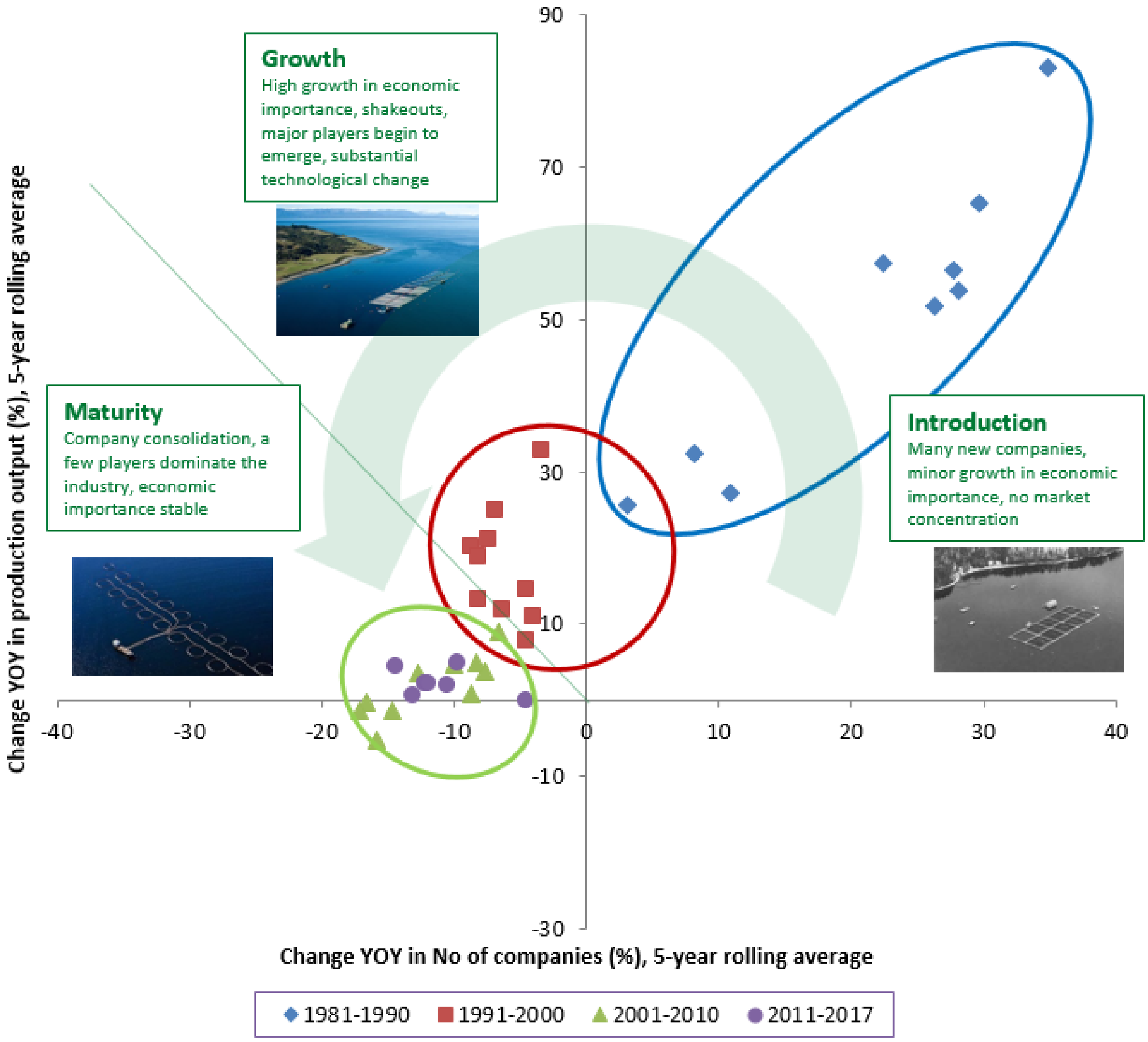


Source: Marine Scotland (2018)

Figure 4-8. Production of rainbow trout in Scotland by size of fish at harvest

The cost of production in Scotland, was 10-30% higher than that in Norway, likely as a result of better economies of scale associated with larger production sites and generally larger industry output in Norway, compared to Scotland (Asche and Bjørndal, 2011). There is a marked increase in the production cost of salmon in the UK between 2003 and 2018, making it the highest cost salmon producing country among major producers (Iversen *et al.*, 2020).

The salmon industry has undergone a considerable transformation since its emergence, in terms of the number of companies it is composed of, their size and the activities they perform, as well as the technologies used for production. The evolution of the salmon industry, which is summarized in Figure 4-9, developed on the basis of data from Marine Scotland (2018), illustrates a strong decline in the number of enterprises in operation in the salmon farming industry in Scotland since the late 80s, accompanied by slowing growth in output. A high level of consolidation following a rapid growth phase is an indication of industry maturity (Deans, Kroeger and Zeisel, 2002). What is evident from Figure 4-9 is that most noticeable structural changes in the salmon industry have taken place in the early ears of its life cycle, which indicates the need for long time series in order to obtain a full picture of the trajectory of change. However, such data series are not always available, particularly for at the company level. This was noted as a limitation; however, even shorter time series can indicate the change over time as was the case with industry consolidation in chapter 3. The change over time, combined with the absolute value of the parameter can indicate the life cycle stage.

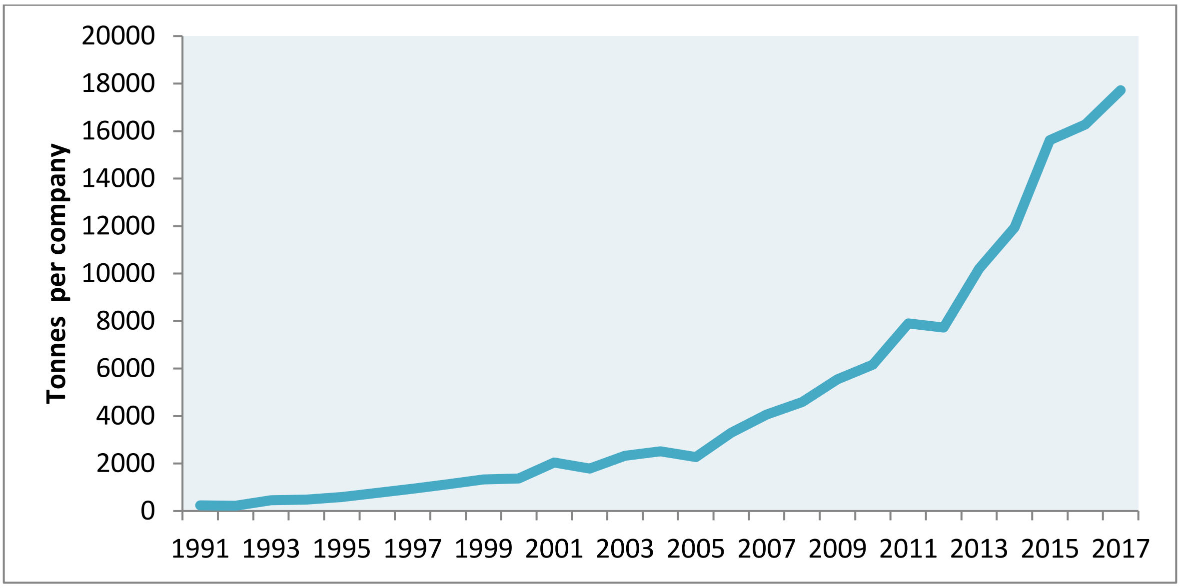


Data Source: Marine Scotland (2018)

Figure 4-9. Scottish salmon industry lifecycle

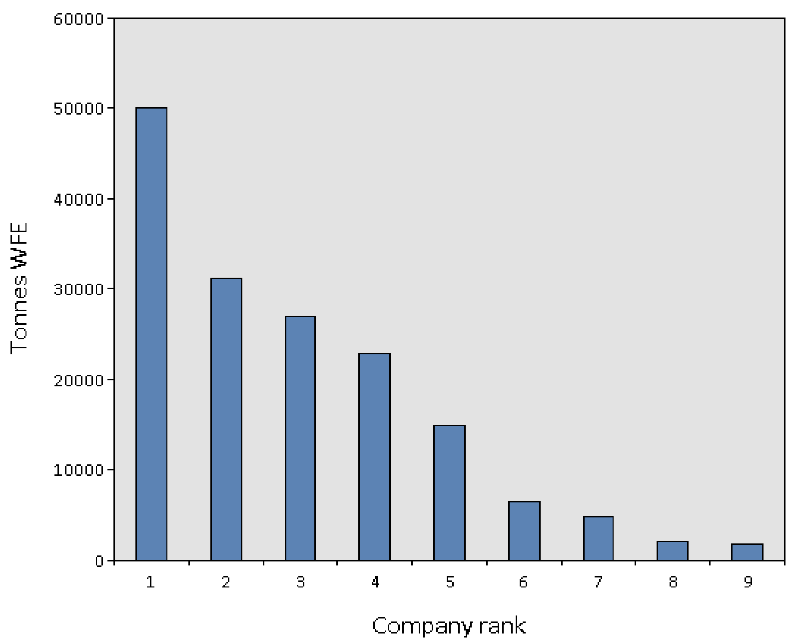
The declining number of companies has been the result of mergers and acquisitions of smaller companies by their larger rivals. This concentration trend has resulted in an increase of the average company size, (Figure 4-10). The concentration level and trend, measured by concentration ratio (CR_4) for salmon and trout (Scotland), has been presented in the previous chapter (Figure 3-13 and Figure 3-14).

Only seven salmon net-cage farming companies and two marine trout farms remained in production as of 2017, four of which were foreign owned subsidiaries of large MNEs responsible for around 80% of the output of the industry (Figure 4-11). Only two locally-owned 'independent' owner-operated companies existed in 2018, which accounted for less than 1% of the total industry output. Not only had the industry become highly consolidated over time but its vertical structure has become more integrated, too. Most of the companies engaged in net-cage salmon or trout farming, included processing facilities (Figure 4-12), while the largest company was the most vertically integrated, covering feed manufacturing, too.



Data source: Marine Scotland (2018)

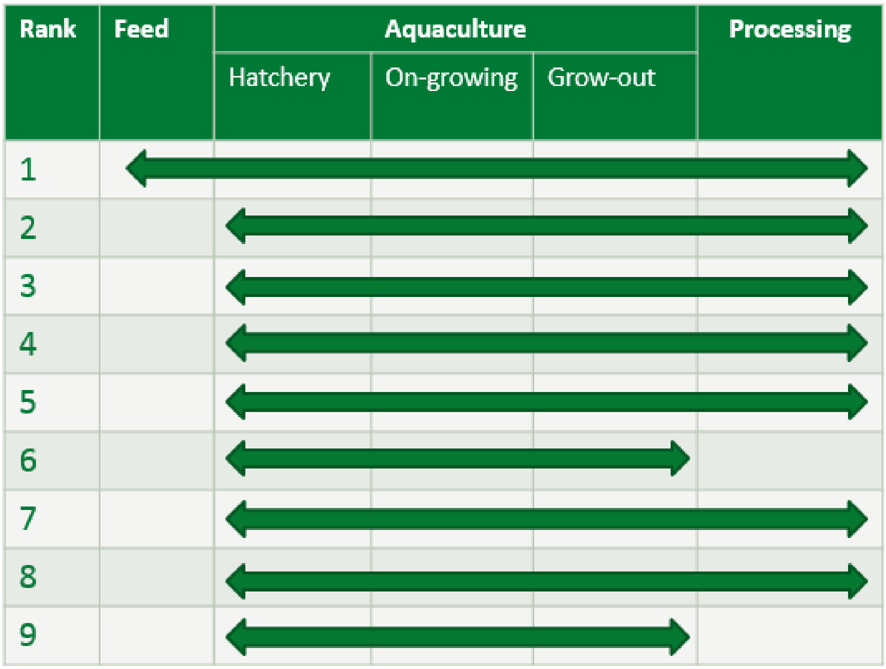
Figure 4-10. Average company size in the Scottish salmon aquaculture industry



The figures for companies 7 and 9 represent marine net-cage rainbow trout while all others – Atlantic salmon.

Source: Kontali Analyse (2018), FAME (2019)

Figure 4-11. Scottish salmonid net-cage aquaculture industry structure according to company output for 2016

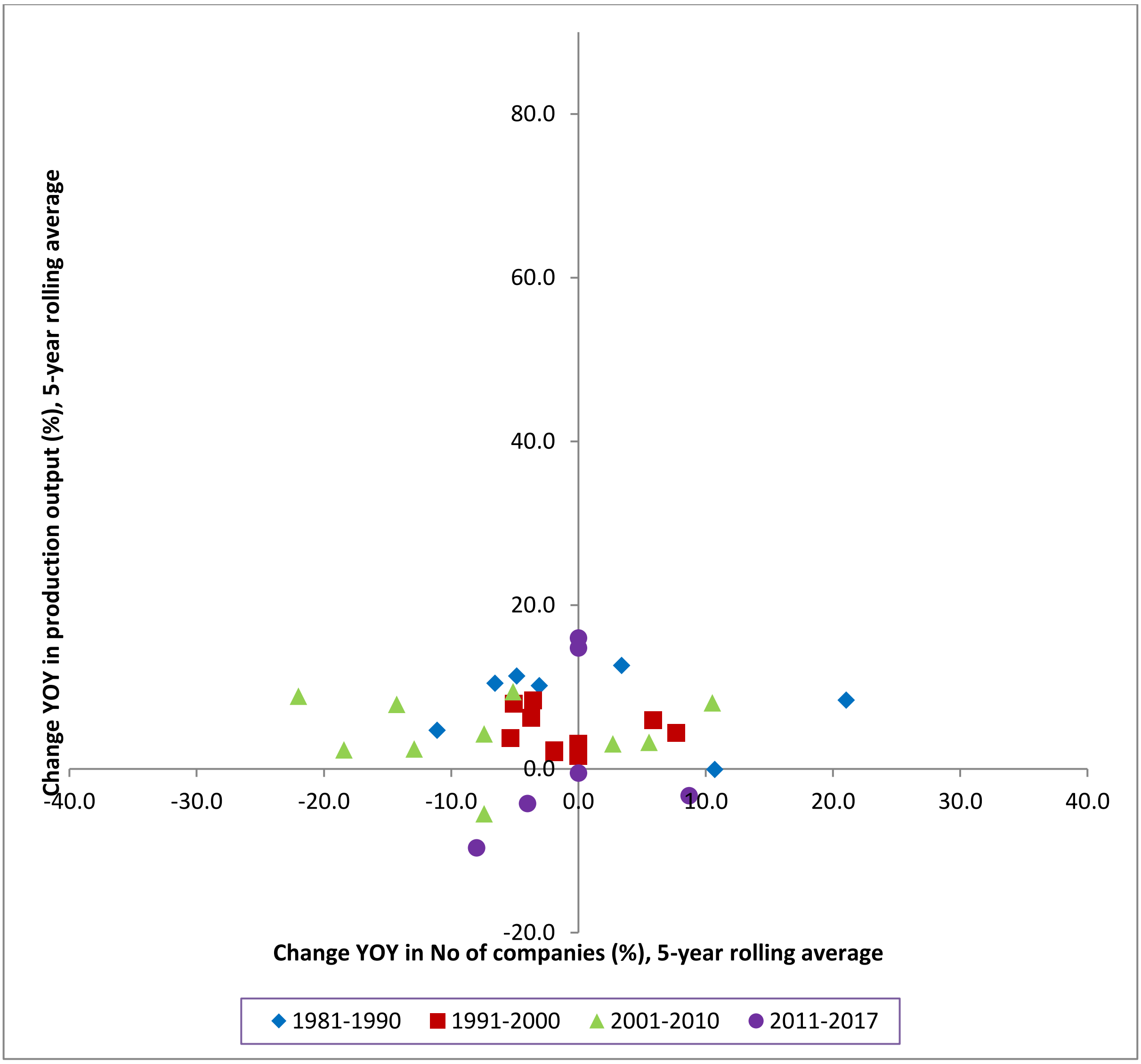


The figures for companies 7 and 9 represent marine net-cage rainbow trout while all others – Atlantic salmon.

Source: FAME (2019)

Figure 4-12. Vertical structure of the Scottish salmonid net-cage aquaculture industry by company in 2016

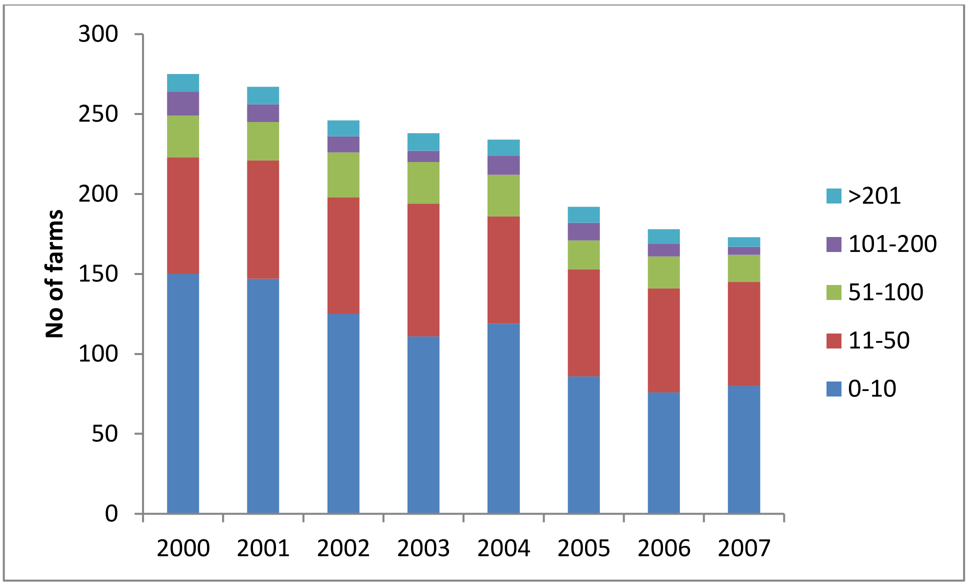
The UK trout sector has followed a much less pronounced trend of consolidation compared to salmon. The much smaller output of the trout industry remains fragmented into more than 300 companies across the country as of 2016. In Scotland, where systematic time-series data was available on the number of companies (Marine Scotland, 2018), there were 24 operational companies in 2015. The two companies with highest growth in the period 2011-2017 were both marine cage operations located in Scotland. Against a background of low output growth and declining numbers, historic trout concentration trends show less clear separation into life cycle stages than were observed in the salmon sectors (Figure 4-13), indicating that it is not always possible to distinguish clearly between maturity and stagnation.



Source: Marine Scotland (2018)

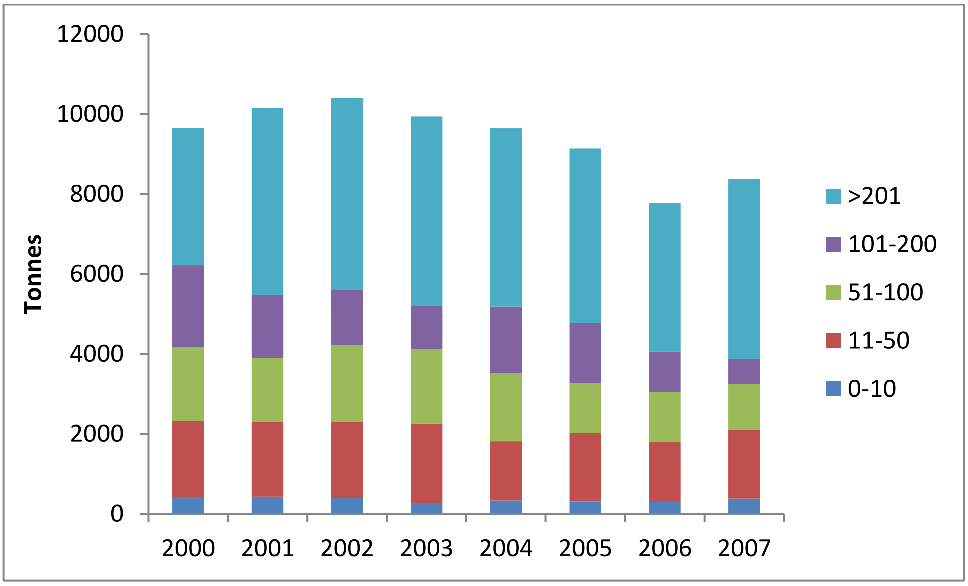
Figure 4-13. Scottish rainbow trout industry lifecycle

In England and Wales there were 109 authorised rainbow trout enterprises in 2012 (Ellis *et al.*, 2015). The small-scale nature of these companies was revealed by the number of employees per company: 100 of those had <=5 employees, 5 had 6-10 employees and 4 has >10 employees. The total number of rainbow trout farms in England has declined in 2000-2007, predominantly in the smallest category (<10 t annual production) (Figure 4-14). The six biggest farms exceeding 200 t in 2007, accounted for about 50% of the total rainbow trout production in England for that year, Figure 4-15. The largest land-based trout company in the UK produces around 1000 tonnes of fish annually, which is smaller than the average marine salmon production site (Ellis *et al.*, 2016).



No data after 2007. Source: CEFAS (2018)

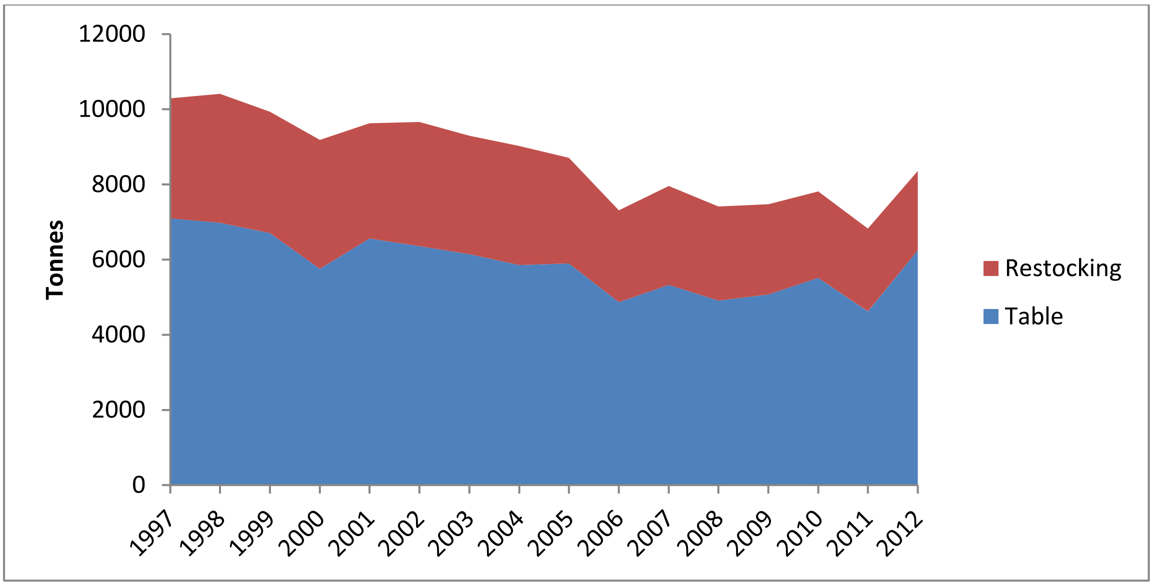
Figure 4-14. Number of rainbow trout farms in England by size (annual output, tonnes)



No data after 2007. Source: CEFAS (2018)

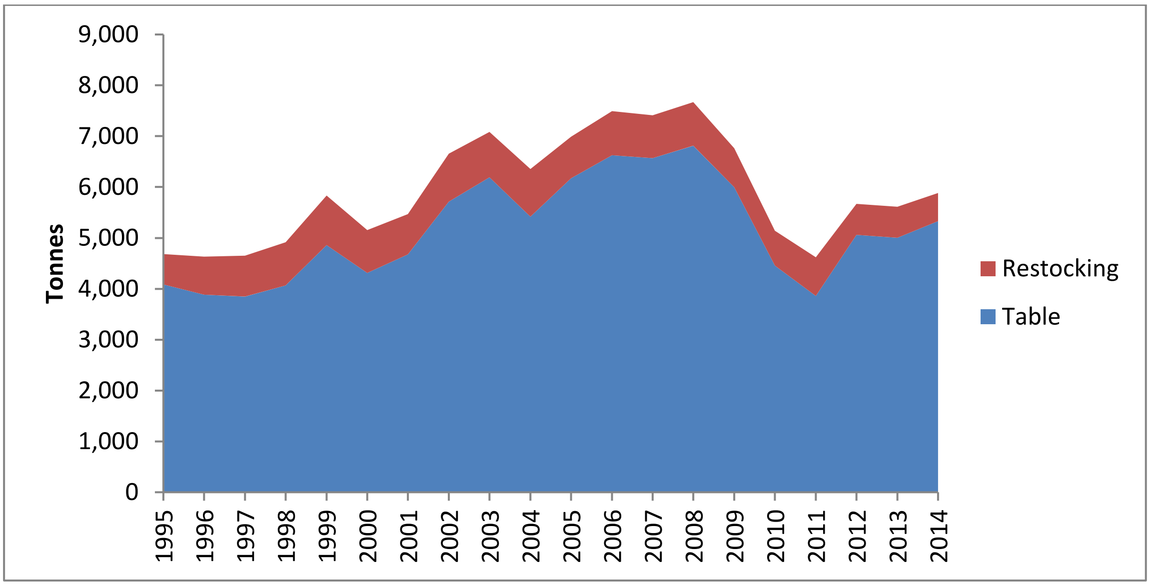
Figure 4-15. Rainbow trout production in England by farm size and year (tonnes)

A significant proportion of the surviving smaller companies involved in trout production have focussed on fisheries restocking for recreational purposes. Still, production for restocking in England and Wales reached about 2,000 t in 2012, a decline of more than 1000 t compared to 1997 (Figure 4-16). In Scotland, restocking production was around 500 t and accounted for 9.4% of total rainbow trout production in 2014 (Figure 4-17).



Source: CEFAS (2018)

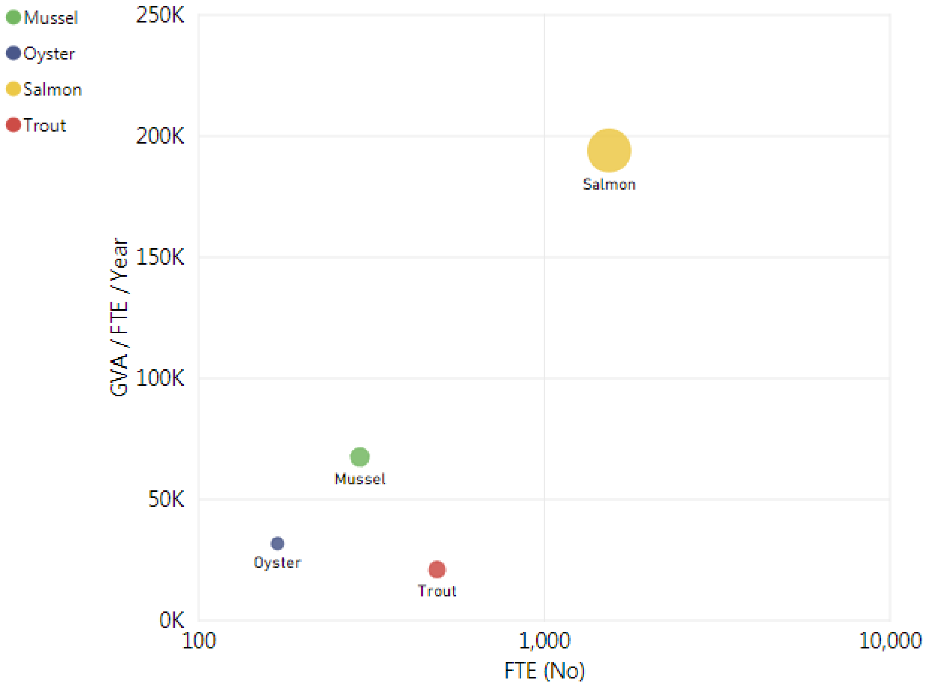
Figure 4-16. Production of rainbow trout in England and Wales by purpose



Source: Marine Scotland (2018)

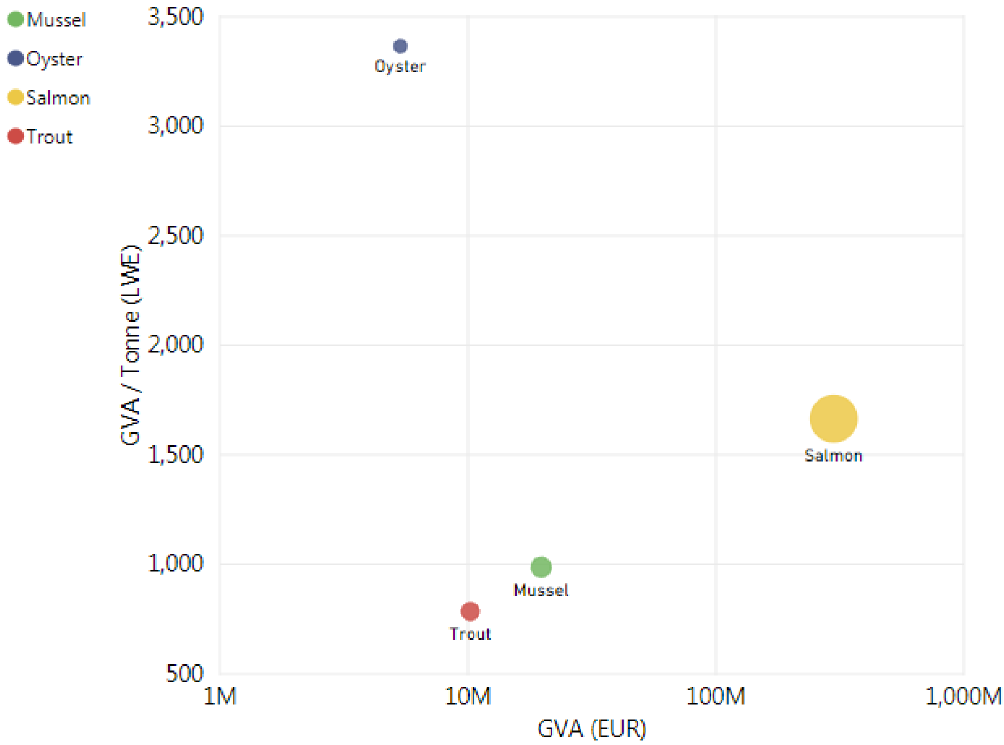
Figure 4-17. Production of rainbow trout in Scotland by purpose

The differences in technology use and industry structure in the salmon and trout are reflected in the significantly higher labour productivity of salmon aquaculture (Figure 4-18 and Figure 4-19).



Data source: STECF (2016)

Figure 4-18. Labour productivity and employment by aquaculture industry in the UK, 2014



Data source: STECF (2016)

Figure 4-19. Labour productivity and employment by aquaculture industry in the UK, 2014

4.3 Discussion

Chapter 3 has highlighted the diversity of aquaculture industries in the EU in terms of their competitive performance and economic contribution. While aquaculture industries are seen as a unified activity and thus, subject to the same type of policy directives, which are primarily linked to growth, it is useful for strategic purposes to distinguish between two types of output from aquaculture: 'commodity' and 'product'. A commodity is the raw material which can be used in further processing to manufacture finished goods. Products, on the other hand, are the finished goods sold to consumers. The main difference between commodities and products is their position in the value chain: commodities are typically in the early stages of production, while products are at the final stage of the manufacturing process. With regards to the salmon market, however, many products are sold only after basic levels of processing generally resulting in homogeneous substitutable product closer to the commodity end of the spectrum (Cojocaru, Iversen and Tveterås, 2020). In comparison to other successful food industries, such as the poultry industry, differentiation in farmed salmon remains rather limited (Asche, Cojocaru and Roth, 2018).

The comparison between salmon and trout aquaculture in the UK has highlighted that major growth differences at the industry level are as a result of the nature of output, in the case of Atlantic salmon - a commodity with global market. This is possible because the species attributes are appealing to a broad range of consumers, with the potential for further increasing market size by value addition and processing into a broad range of products fitting into a broad range of market segments (Cojocaru, Iversen and Tveterås, 2020), as well as the production method are subject to productivity growth (such as through economies of scale) to reduce the cost and price of the product and thus further increase demand. On the other hand, plate size trout – a product with little scope for value addition, sold whole directly to end consumers, can be seen as a finished product, appealing to a limited number of consumers.

Consumer preferences play an important role in explaining the success of fish products on the market. Seafish reports that the main reasons why British consumers do not eat fish at all are negative experiences in consumption such as taste, smell, texture, appearance, bones, cooking demands (Seafish, 2018). In developed countries successful products are those that have successfully removed barriers to consumption, as well as reduced price (Carlucci *et al.*, 2015). The fish products that have the wides appeal in the UK do not have strong flavour and bones, are not demanding to prepare. The most popular product forms according to Seafish (2018) are tinned fish, battered or breaded fillet or natural fillet, smoked fillet, fish fingers and fish cakes, The success of salmon and whitefish on the EU market to a great extent can be attributed to the 'generic' nature of these commodities, and therefore access to large markets (Anderson, Asche and Garlock, 2018). Many seafood products have become commodities due to standardisation and globalisation of markets (Anderson, Asche and Garlock, 2018). These are the products which have experienced the fastest growth in demand and production e.g. farmed tilapia and pangasius (Asche, Roll and Trollvik, 2009), tropical shrimp (Cai, Leung and Hishamunda, 2009) and salmon (Felzensztein and Gimmon, 2014).

The success of the salmon aquaculture industry has been attributed largely to the versatility of salmon as a raw material making possible the manufacturing of a wide range of products and thus enter numerous market segments (Landazuri-Tveteraas *et al.*, 2018). Larger fish tend to be more suitable for retail as natural fillets, which is due to their higher technological value. The technological value generally depends on two parameters: the yield of preliminary processing and the quality features of fish meat and by-products such as: flavour, texture, appearance, size and bone content. While value-added products based on plate-size trout can be developed (Goulding, 1983), small size fish generally have lower technological value when it comes to value added processing because of higher bone content (Bykowski and Dutkiewicz, 1996). Change of product form, at the aquaculture stage of the value chain e.g. harvesting at a large size, would necessitate a change in system and access to new set of resources which is largely not applicable to resource constrained small enterprises. However, development of certain kinds of value-added products, such as the increasingly popular smoked trout products (Hambrey and Evans, 2016) is still a possible route for improving the viability of the industry. Alternative solution is the producer organisation or cooperative through which sufficient scale is achieved to make processing, product innovation and marketing and export effective and economically viable (Forleo *et al.*, 2018).

The nature of aquatic resource and the production systems that use them have a major impact on industry structure and thus – growth and competitive performance. Due to the technology itself and regulation, marine sites are much larger which allows achieving economies of scale and consolidation of ownership. This is a crucial determinant of success since in a commodity market, achieving economies of scale and thus reducing costs has been a major success factor (Asche *et al.*, 2013; Kumar and Engle, 2016; Nielsen, Asche and Nielsen, 2016). On the other hand, the availability of freshwater and the regulations around its abstraction and release of nutrients in the outflow usually limit the capacity of the production site to small volumes of annual harvest (Jokumsen and Svendsen, 2010). This prevents economies of scale to be reached and sets the basis for a fragmented industry. The fragmented small-scale ownership in the land-based trout sector also serves as a limitation for investment and upgrading of the systems to improve productivity, since family-owned businesses are usually constrained in terms of financial resources and are risk-averse (Nielsen, Asche and Nielsen, 2016).

One of the main differences between the salmon and trout industries in the UK, that helps explain the difference in performance and growth, is thus in their structure. The structure of the industry plays a critical role in determining productivity growth (Asche *et al.*, 2013), international competitiveness, as well as the overall profitability potential in the industry as it affects the barrier to entry, the rivalry within the sector and the bargaining power of its members against buyers and suppliers (Porter, 1980). Salmon aquaculture in all main production countries has become dominated by large scale vertically integrated companies (Kvaløy and Tveterås, 2008; Olson and Criddle, 2008; Asche *et al*., 2013) The growth in size of firms has been driven by economies of scale and has brought about significant productivity growth (Asche, 1997), supported also by improvements upstream in the value chain, such as targeted feed, improved fingerlings (Sandvold and Tveterås, 2014; Sandvold, 2016) and production technology (Tveterås and Heshmati, 2002). This trend has been observed in other agri-food value chains as well. Nonetheless, total productivity growth in salmon aquaculture has plateaued (Nguyen *et al.*, 2017). The profitability of the UK salmon industry has been examined in more detail in the following chapter.

One of the primary reasons is linked to the change in power dynamics, particularly the rising power of multiple retailers – the main buyers in the salmon value chain – due to concentration in this industry (Murray and Fofana, 2002). The trend of concentration in the retail node of the value chain is not confined to the UK but is present across Europe and has significant implications for both downstream (consumer) and upstream (processor, harvester) levels of the seafood chain (Asche, Nøstbakken, *et al.*, 2011). The structural change in the salmon retail from independent shops to large multiple retail chains is not new and has been observed by early studies on the salmon market (Bjorndal, Salvanes and Andreassen, 1992). Guillotreau, Le Grel and Simioni (2005) identify 1992 as the date of this structural change by using time series data and econometric models. A large difference in the size of supplier and buyer results in an asymmetric relationship whereby the usually smaller supplier is more dependent on the larger buyer than the buyer is on the supplier. This results in high bargaining power for the buyer and erosion of the profit margin of the supplier (Porter, 1985).

With a greater proportion of fish retail going through supermarkets, where the key success factor is the ability to source the required quantity of fish and continuity in supply, there has been an increasing emphasis on scale (Olson and Criddle, 2008a). Therefore, the growth in the concentration of the retail market has likely been a main stimulus the consolidation and vertical integration of the upstream links of the value chain including the salmon industry. The outcome of these changes is a highly coordinated and integrated value chain with fewer and larger agents.

Kvaløy and Tveterås (2008) develop a theoretic model to explain the tendency for high level of vertical integration in the salmon in the Norwegian salmon industry, considering as the primary reason a change in technology towards more capital-intensive processing techniques, towards automation and lower labour inputs. As processors become more capital intensive, their volume requirements increase, as well as the number of specifications of raw materials, which makes them more vulnerable to opportunistic behaviour on behalf of their suppliers (farmers). Additional reason is the higher level of concentration in farming which makes the downstream party more vulnerable as the value of each contract increases. However, what the model suggests is that downstream actors i.e. processors would integrate backwards, while in reality (at least in the UK) it is mostly farming companies that integrate forwards into processing. Therefore the reasons cannot be simply the larger and more capital intensive nature of processing operations, but likely includes other industry dynamics components discussed above, covered also by (Olson and Criddle, 2008b), and in particular the balance of power between buyers and sellers. This balance of power is dynamic, leading to unpredictability in pricing, which is particularly important when there is a high volume of transactions between two companies. Frequent transactions provide more opportunity for exploitation and can lead to a rise in transaction costs (Levy, 1985). Since reducing costs is a vital success factor for large share of the companies in mature industries (Porter, 1980), one way of reducing transaction costs and the risks associated with a transaction is through contracts (Larsen and Asche, 2011). In a mature industry futures contracts (Oglend and Sikveland, 2008; Oglend, 2013) are increasingly being used to govern transactions between stages in the value chain, not just handle price risk, but other parameters as well such as volume (Kvaløy and Tveterås, 2008)trans.

However, contracts provide only partial control through specifications (being never exhaustive in nature) and also introduce some risk such as holdup (Kvaløy, 2006). Vertical integration could eliminate the problem, balance the power between buyers and sellers and reduce transaction costs (Levy, 1985). Olson and Criddle (2008) discuss changes in price and availability of inputs, changes in the demand for outputs and output attributes in addition to changes in technology, as reasons for the changing structure and organisation of the Chilean salmon industry. In explaining the reasons for the vertical integration in the Chilean salmon industry they focus on the requirements of buyer markets (retailers and governments in export countries) for traceability and other forms of food-safety assurance which increase the transaction costs.

In addition to the reduced number of fish mongers and market stalls (Murray and Fofana, 2002), growth in supermarket sales of seafood has influenced the format of seafood products. The format of fish presentation which was typical for a fishmonger's counter in the past, has changed to a typical supermarket format (Landazuri-Tveteraas *et al.*, 2018), where demand for convenience (Ankamah-Yeboah *et al.*, 2020) and scale advantages from shelves, make the counter less attractive. This trend gives advantage to larger sizes of fish which can be filleted, and the flesh used as a basis for value-added convenience products. In the category of fresh salmon products, which can be split up into whole salmon and fillets, the dominance of fillets has gradually increased over the period 1992–1999 (Guillotreau, Le Grel and Simioni, 2005). The share of salmon sold under relatively unprocessed product forms has been declining steadily in the UK (Asche, Nøstbakken, *et al.*, 2011). Guillotreau, Le Grel and Simioni (2005) observe that in France, the primary processing is increasingly subcontracted by the retailers to domestic primary processors. However, the results here suggest that almost all salmon farming companies have vertically integrated into primary processing, although larger companies have developed also secondary (value-added) processing capacity and increased the share of VAP products in their output over the last decade (MOWI, 2020). The rest of secondary processing is done by independent smokers and seafood processing companies, often co-located in clusters e.g. Humberside (Noble, Quintana and Curtis, 2016). The need for consistent standards and vertical integration in the chain has increased as retailers try to protect their image from attacks by pressure groups and ensure trust in the relationship with their clients. Retailers demand stringent product specifications and delivery arrangements and inspect the production facilities of their suppliers. The ability of salmon grown in marine net cages to meet the new demand specifications has resulted in its successful growth, while the inability of the land-based trout industry to adapt has meant decline for its products in the UK. On the other hand, an attempt of the marine trout industry to reverse the trend in demand by growing larger fish, has meant entering into competition with salmon, creating a different set of challenges, which will be explored in the next chapter.

Additional means to balance against the high bargaining power of supermarkets is the development of a strong brand. Brand building is a form of differentiation which can be pursued at the company-level (which is discussed in more detail in the following chapter), or at the wider sectoral level. The motivation for product differentiation is value creation by providing benefits not readily found in competitor products and thus achieving above average profitability (Porter, 1985). Differentiation through branding at the sectoral level has been the objective of the Scottish Salmon Producers Organisation (SSPO). One of the primary reasons has been to compensate for the higher production costs in Scotland, which are the result of complying with strict regulation and the inability to achieve economis of scale found in Norway, (Asche and Bjørndal, 2011). Earlier investigations by Asche and Sebulonsen (1998) have concluded that Scottish farmers do not seem to have succeeded in any extent in differentiating their product by origin on the French market, part of a homogenous EU market for salmon, particularly as compared to Norwegian producers. However, more recent publications state that Scotland offers a premium product, at about 10% above the world price (Asche and Bjørndal, 2011), a sign of successful differentiation. One of the labels which Scottish salmon producers have used to differentiate their products over the years is the French label 'Label Rouge'. Scottish Quality Salmon (SQS) is the holder of Label Rouge, which is audited by a third party certyfing body. This label promotes taste qualities by focusing on welfare, slow growth and a high content of marine ingredients in the feed (Cojocaru, Iversen and Tveterås, 2020). Moreover, it can be used with ease by retail chains since it is owned by the French government (Mariojouls and Wessells, 2002). Scottish salmon was the first fish and the first non-French food to receive this accolade in 1992 (SSPO, 2020). In 2004, Scottish salmon obtained also Protected Geographical Indication status (PGI) "Scottish Farmed Salmon", granted by the European Commission. PGI is awarded to a product or a food with strong links to its geographical origin. It is linked to the name of a location and aims to protect and promote the designation of a quality food or farmed product. (European Commission, 2020d). In this sense, an important intangible resource in this category is the image of Scotland, often seen as a 'pristine' and 'wild' environment, which has been as a source of differentiation from other country-producers based on provenance. In the case of rainbow trout "Quality Trout UK", a certification developed by the British Trout Association (BTA) has been in operation since 2000 and focused on best practice production methods (QTUK, 2019), however, the extent to which it has been successful in achieving above average profits is unclear.

Research on market integration over the years has shown that salmon of different species, whether farmed or wild, are close substitutes (Anderson, 1985; L*in et al*., 1989; Asche, Bjørndal and Salvanes, 1998; Asche, Bremnes and Wessells, 1999; Clayton and Gordon, 1999; Jaffry *et al*., 2000). Due to their pink flesh[10] and similar texture, rainbow trout is also considered a close substitute to salmon and is thus integrated on the same market (Asche *et al.*, 2005; Virtanen *et al.*, 2005), particularly so when it comes to large-size sea water grown trout, which are filleted and processed into products which are closely resempling salmon-based ones. Therefore, the demand and prices of salmon, would also affect that for trout. The markets for fresh and frozen marine-grown rainbow trout are tightly integrated with fresh Atlantic salmon and defined by the prices of salmon meaning that many consumers consider salmon and marine grown-trout substitutable (Landazuri-Tveteraas *et al.*, 2020). Evidence of the competition between salmon and rainbow trout industries in Filand and associated decline in marine trout farming has been explored by Saarni *et al.* (2003) and Virtanen *et al.* (2005). In their research, these authors link the decline of the Finnish 'salmon-trout' industry to the change in trade policies that the county has experienced in the 1990s. During the protectionist regime in the 1980s Finland has been a major producer of marine-reared trout but with trade liberalisation linked to the joining the EU in 1995, imported salmon from Norway has flooded the market and gradually displaces the locally produced salmon-trout, causing a major decline in the industry. While not identical, the case to a great extent paralles the story of the UK trout industry.

4.4 Conclusions

In this chapter the competitive performance of two of the major aquaculture industries in the UK has been examined and the reasons for the differences in performance have been investigated. The analysis has highlighted the interaction between the development trajectories of aquaculture industries resulting from the integration of their products on the same market. The underlying factors that have enabled the salmon industry to reach a stage of maturity have been the differences in demand characteristics (higher value-addition opportunities for larger size salmon through primary processing), the combination of natural endowments and technology which have allowed economies of scale to be reached associated with price decline and mass market for salmon, the rising importance of retailers in the distribution of seafood and their associated high bargaining power. These interlinked factors have acted to promote the development and maturation of salmon aquaculture and the stagnation of trout.

[10] The colour of flesh is dependent on the addition of pigments to the fish feed. Portion-size rainbow trout is also available in white-flesh form, particularly on the Eastern European market, parts of Germany and Italy. As such, it competes with other white-flesh species, such as those supplied from capture fisheries, rather than with other salmonids (Nielsen *et al.*, 2007).

Chapter 5: Strategic positioning and firm-level profitability: a focus on SMEs in the UK trout and salmon value chains

5.1 Introduction and objectives

The previous chapter examined determinants of international competitiveness at industry level. The aim of this chapter was to investigate company level competitiveness as measured by profitability and uncover its determinants. In market structures other than monopoly, profitability is an important measure of competitiveness. One of the most widely adopted definitions of competitiveness at the firm level is the ability of a company to maintain its competitive advantage and increase its profitability over the long term (Porter, 1985).

According to the structure-conduct-performance (SCP) model (Bain, 1959), the performance of industries and of individual firms, including when measured as profitability, is influenced by the strategic action (conduct) of the firm and by the nature of the competitive environment (industry structure). However, modern strategic management theory recognises that, in addition to the (external) factors of the business environment competitive strategy formulation needs to consider the (internal) resources and competencies of the firm (resource-based view), too (Barney, 1991; Rumelt, 1991; Luo, 2014).

As discussed in the previous chapter, growth in aquaculture output depends on a multitude of factors, many of which are beyond the control of the aquaculture industry itself. Characteristics of related and supporting industries, particularly the processing industry, the link of the production chain closest to the end consumer, are key determinants of the performance of the entire value chain (Asche, Cojocaru and Roth, 2018). Therefore, the analysis in this chapter extends beyond aquaculture and covers activities along the seafood value chain, including primary and secondary (value-added) processing. As with the previous chapter, the focus remains on the salmonid value chain in the UK, however covering only companies engaged with marine net-cage aquaculture of Atlantic salmon and rainbow trout and their processing, not including the largely stagnant freshwater trout sector.

There is little empirical evidence of the competitive strategies that aquaculture firms employ as the industry reaches its mature and declining stages. However, the question is important since more sectors will start entering maturity, as the relatively new aquaculture industry continued to develop and concentrate globally. Even though SMEs form a small proportion of the turnover of a mature and consolidated industry, the current EU's aquaculture industry, as a whole, is still dominated by SMEs (European Commission, 2015) and their continuous survival depends on their successful adaptation to the new conditions presented by a changing environment.

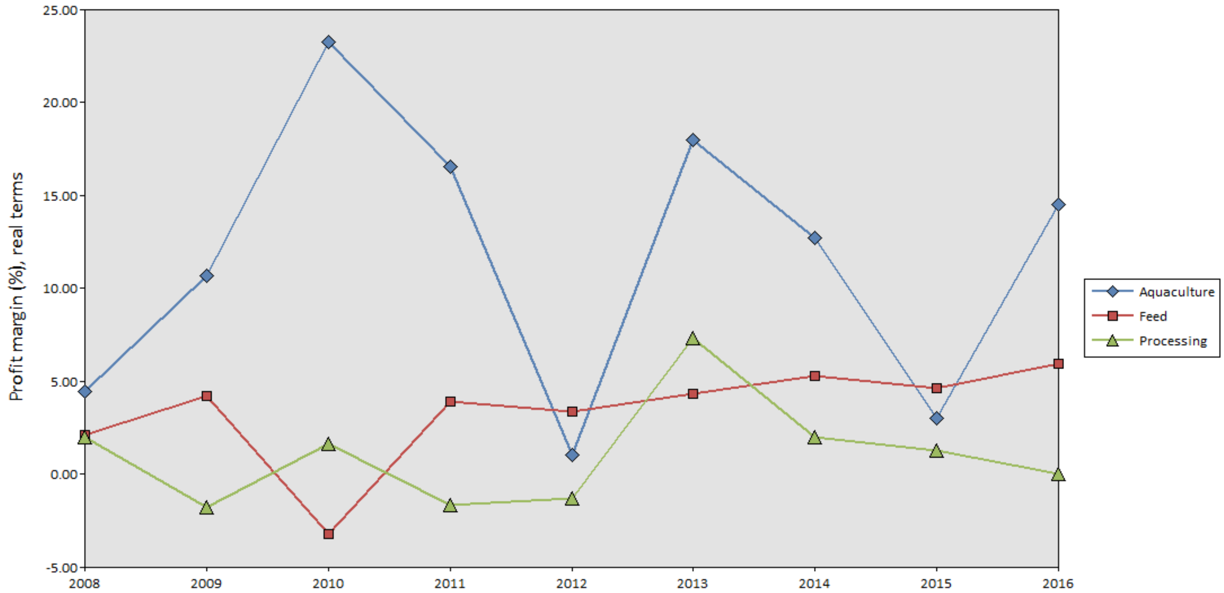
Therefore, the focus of this chapter is on the strategic implications of industry maturation and decline for SMEs. In particular, a focal point of the analysis is the strategic adjustment necessitated by the change in power dynamics brought about by concentration and consolidation within the value chain. The existing literature on primary resource industries indicates that in the growth phase of the industry life cycle, strategies are commonly production oriented, such as mastering the production process, securing material supply, reducing costs, increasing market share, while in the maturity phase unique strategic positions become vital for the success of the company, particularly SMEs, who are unlikely to be able to achieve a low-cost producer position achievable through scale economies (Bush and Sinclair, 2006). The lessons learned are applicable not only to SMEs in consolidated industries at the national level, but to global markets in which SMEs compete with imports from lower-cost producers.

The aim of this study was to investigate the relationships between the business environment, company-level resources and competencies and strategic positioning along the value chain of one of the most evolved and mature aquaculture commodities: marine-grown salmonids in the UK. The UK salmon aquaculture can be seen as an empirical ground for understanding the opportunities and challenges that companies will face in other aquaculture industries as they progress through their life cycles towards maturity.

5.2 Results

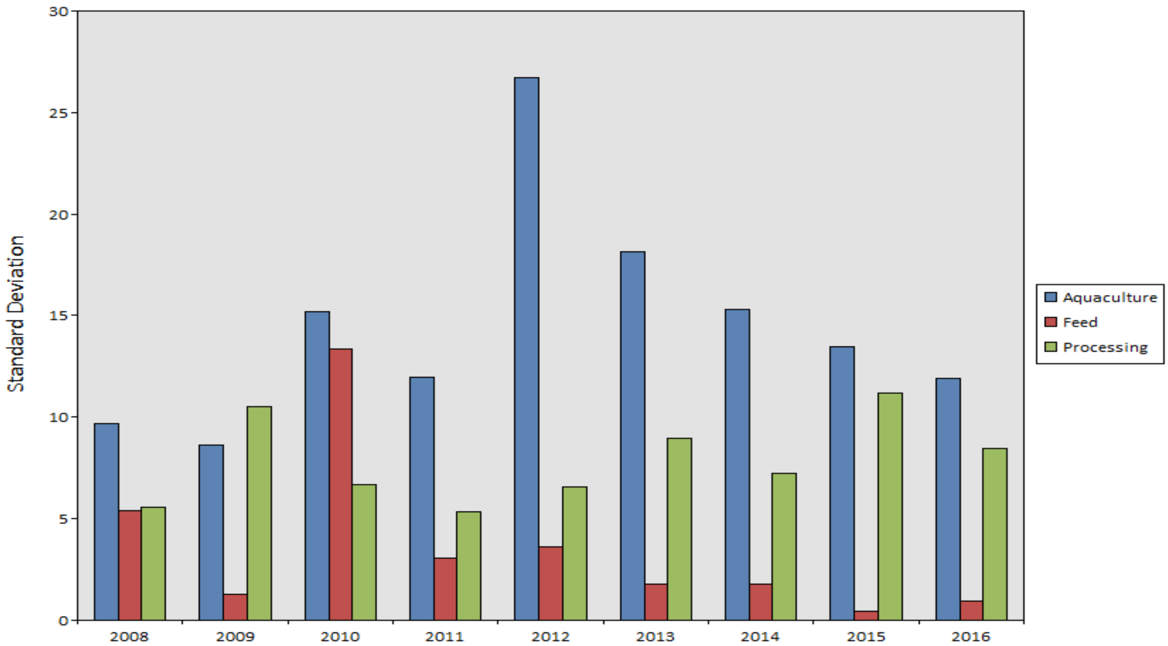
5.2.1 Industry level profitability

Data on the average profitability of companies in three of the main nodes of the salmonid value chain in the UK: aquafeed manufacturing, farming (aquaculture) and processing indicate that among these three nodes, profitability is highest in the farming node of the value chain (Figure 5-1). However, it can be also seen that in it, the variation in profitability between years and between companies was also the highest. Companies active in the processing stage marked the lowest average profit margin, below 5% in most of the years of the period examined and more frequently turning a profit loss, relative to companies involved in other activities of the value chain. However, aquaculture companies were also subject to the widest inter-annual profit fluctuations (Figure 5-2).



Aquaculture covers net-cage farming only. Source: FAME (2019)

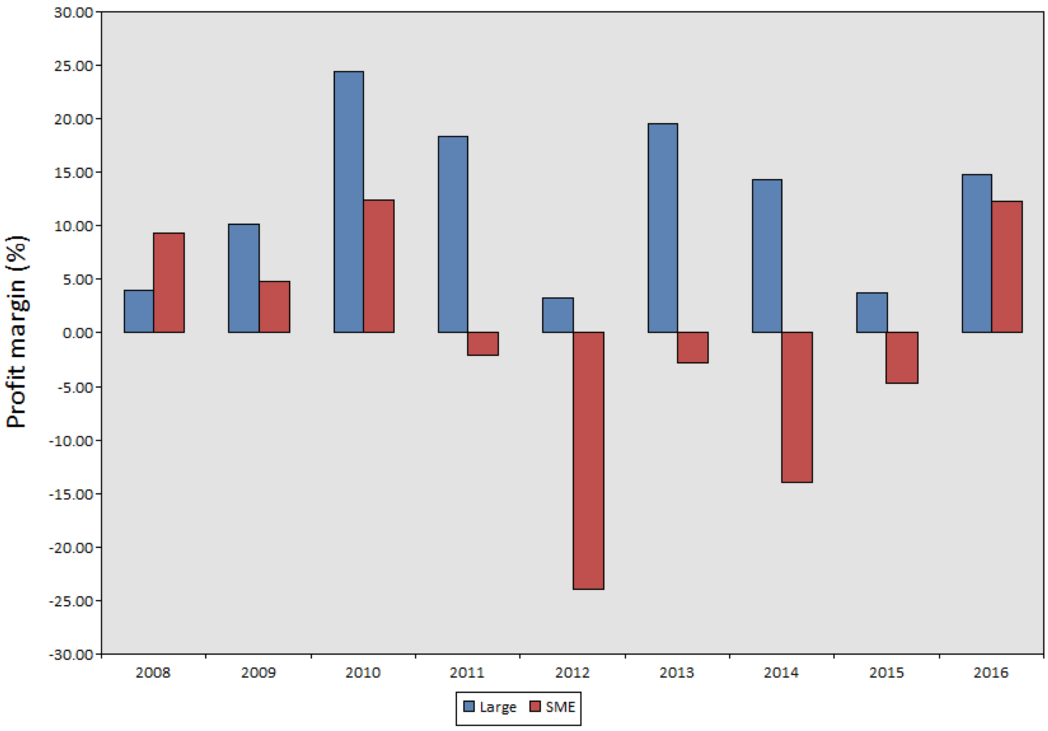
Figure 5-1. Mean Profit margin by major industry along UK salmonid value chain 2008-2016



Source: FAME (2019)

Figure 5-2. Variability in profit margin between companies within different nodes of the UK salmonid value chain

Disaggregated by strategic group (Figure 5-3), it is also apparent that SMEs on average have a profit margin consistently lower than that of large-scale enterprises with the exception of one of the years in the period examined.



Source: FAME (2019)

Figure 5-3. Profitability of salmonid net cage aquaculture by company size

5.3 Firm-level strategic positioning case studies

To understand the determinant of profitability at the company level three case studies of SMEs in the UK salmonid value chain were conducted, with selection based on attributes described in Table 2-6.

5.3.1 Company A: owner-operated Atlantic salmon grower

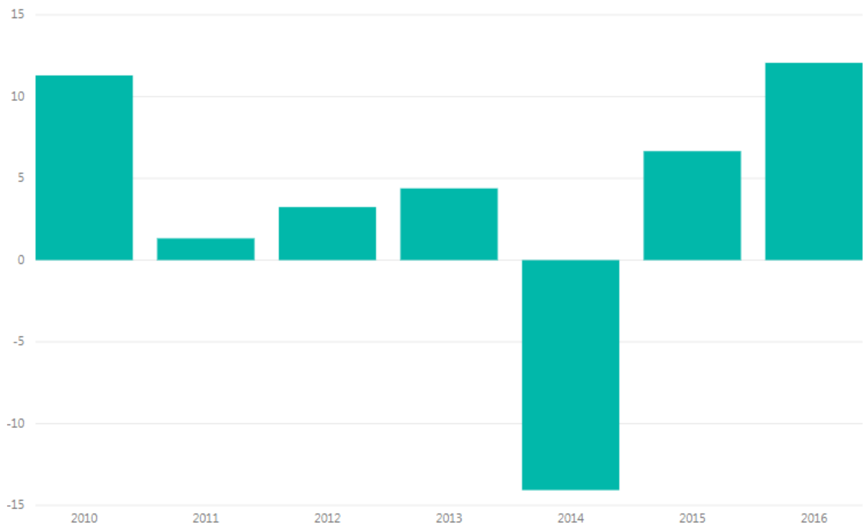
Founded in late 1970s, the company is one of UK's oldest independent, owner-operated salmon production businesses, and as of 2019, the smallest salmon farming business in Scotland. In a period of rapid consolidation and concentration in the UK salmon aquaculture industry, the company had remained locally owned through a management buyout. With around 50 employees and turnover of £17 million in 2019, the company was classified as an SME, whilst remaining the largest employer and a centre of economic activity in a small rural community.

The company consists of three marine grow-out sites, a freshwater smolt production unit, a small primary processing plant and a sales and administration office in proximity of each other.

Its farming operations are located on the west coast of Scotland where the coastline provides a suitable environment for Atlantic salmon farming. The grow-out facilities consist of relatively small, square wooden and/or steel cages, suitable for more sheltered sites with more limited carrying capacity. Some of the facilities, constructed by the company itself, used technology common in 1980s and as of 2019 were some of the smallest in operation according to Scottish and global salmon farming standards, where scale economies have underpinned competitiveness. The company's annual production was around 2000 tonnes a year.

The product range comprised whole fish sized from 2-10 kg with an average 4-7kg fish for the first half of the year and 3-5 kg in the second half of the year. A proportion of the produce were gutted and further processed into fillets according to customers' requirements, at the company's own local primary processing plant.

Prior to 2014, the company had been a supplier to a major low-cost retail multiple serving the domestic market, however, the retailer ceased purchases following activist reports documenting excess sea lice loads at some of its sites. Loss of access to this buyer resulted in a 20% sales drop and a loss of nearly £1million in 2014 (Figure 5-4). Since then the company has refocused its marketing strategy by redirecting supply to alternative distribution channels, targeting a wider geographic market through increased exports. Thus, after 2014 most of the company's produce sold on the domestic market was directed to other SMEs including small specialised retail outlets (e.g. fishmongers, farm shops, smokers, seafood distributors) and high-end restaurants.



Source: FAME (2019)

Figure 5-4. Profit margin (%) of company A

The proportion of products destined to export has increased from 20% in 2012 to 73% as of 2019 with a particular focus on Asia, the USA, Middle East and Europe. The company has been listed three times (2019, 2018 and 2015) in the “Sunday Times SME Export Track 100” which ranks Britain’s 100 SMEs companies with the fastest-growing international sales over the latest two years.

In line with its position as a small-scale producer, the company has adopted a niche strategy to differentiate itself from its larger competitors. It has focused on the development of an own brand of products emphasising the ‘all natural’ approach to farming, including ‘hand-rearing’, i.e. stronger reliance on manual labour in conducting routine animal husbandry tasks as compared to other companies in the industry. Further, the firm has been using a custom-made ‘environmentally friendly fish feed’ composed of trimmings from the fish processing industry as a source of protein, excluding fish meal from reduction fisheries still widely used in the UK salmon sector. The company stated it has moved to exclusive use of cleaner fish technology instead of chemicals to combat parasitic sea lice, a major health problem in salmon aquaculture.

It has targeted the educated consumer in upper-end market segments, who respond to market messages signifying attributes such as rural, rustic, local, traditional, owner-operated, hand-reared, small-scale, environmentally-friendly, natural, organic, and are willing to pay a premium for a product “with a story”: *‘The thing about the [American] market is you’re dealing with a very highly educated consumer. They want a strong story as to why they should buy our salmon. If you can tune into that there is a big potential market.’ CEO (Pers. comm., 2017)*

The company also claimed ‘all natural’ approach also resulted in a tangible difference in the taste quality of the product: *“The fact that we’re selling to the same customers every week is because they like the taste of the product. We’re supplying a product that is noticeably different to the alternatives” CEO (Pers. comm., 2017).*

A key constraint for the success of family-owned businesses is the access to funding for financing new projects. As a privately owned, owner-operated company, it has relied on equity and debt funding to finance its projects. *“If you’re listed on the Oslo stock exchange raising new capital is significantly cheaper than if you’re privately owned and rely on internal resources or external debt funding”* CEO *(Pers. comm., 2017)*. Instrumental in accessing capital has been a local bank, as well the EMFF and the Scottish government which in 2017 supported with nearly £1million the acquisition of two marine sites which the company has been previously leasing from other farmers.

5.3.2 Company B: vertically integrated rainbow trout leader

Starting out as a cold-water prawn (aka' scampi') processing business in the 1980s, Company B was, as of 2019, the UK's largest trout producer. Within a background of a declining UK trout market, and associated business failures, the company has entered the trout industry by acquisitions of businesses experiencing financial difficulties.

The company had entered the trout processing sector in 2004 when it had acquired a relatively large trout processor which has also given the company access to its customers including large retail chains. In 2008 the company also acquired a bankrupt trout aquaculture business which was estimated to have added £35 million of annual turnover and nearly 500 employees. The acquired business had 25 land-based trout farms, a portfolio of branded products including hot- and cold-salmon, pickled herring and smoked haddock. In 2008 the company also acquired a number of marine sites from a small-scale net-cage trout farming company in Scotland. After these acquisitions, the company controlled over 80% of the Scottish trout aquaculture industry, however it rapidly divested its pond production assets and moved exclusively into marine cage farming.

As of 2019, the company's value chain spanned fish farming, including production of own juvenile fish, freshwater and marine water grow-out farms, as well as primary and secondary (value-added) processing. The firm grows trout to three size categories: portion size (300-400g), standard 4-5 kg and large 7-8 kg. Portion size fish were grown in freshwater sites and marketed as whole fresh fish. However, the larger size fish grown-out at marine sites represented the main output of the company, of which 70% was of 4-5 kg. This size class was used as a basis for further processing at the company's own processing facilities and the development of a wide range of value-added products. Its marine site - main grow-out facility- is an important advantage to the company as it allows it to grow fish to a large size cost-effectively. The costs of growing trout to 4-5 kg were similar to those of salmon. In addition, the low salinity of the water in its main loch concessions provides a more suitable environment for the rearing of trout than salmon. Also, lower average salinity reduces the severity of sea lice infections in addition to trout being generally less susceptible to this parasite, which represent a major challenge to the salmon industry. Portion size fish and value-products were marketed through the domestic multiple retail sector (Sainsbury's, Tesco, M&S) predominantly under retailers' private labels, where some of the products were labeled as loch trout. The remaining 30% of the marine net-cage grown fish if size 6-7kg is a niche product, exported by airfreight whole gutted – mainly to the US and Canada, where it is destined to the high-end food service sector. These exports were marketed under the company's own brand achieving a higher profit margin of around 20-30%.

The lack of significant domestic branding effort was associated with the high cost of branding relative to the size of the company and its choice of marketing channels (i.e. predominantly multiple retail chains), combined with a general image problem of trout in the UK underpinning the stagnation of the 'plate-size' pond sector (Chapter 4). Main domestic competitors for company B included some of the largest seafood secondary processors in the country. All suppliers aim to achieve preferred supplier status, but company B with its lower volume had to do this by agreeing to diverse product lines, which may involve unprofitable products. On the other hand, its largest (salmon producing) competitor, consistent with its supply volume, had much more streamlined processing of just 1-4 product lines, resulting in scale efficiencies.

Thus, the company has been striving to increase its operational efficiency. The company's set of fish farming facilities comprise a combination of different systems, acquired from other producers and developed by the company itself, and lack standardization. Divestments and standardization of its core cage-farming juvenile supply and production processes and expanding production has been a main area of investment.

The company has endeavored to double its annual output from its farming operations to 10,000 tonnes. However, expansion of production is constrained by the availability of licensed marine production sites. New sites are difficult to develop while in acquiring a production site the company competes against much larger buyers and has been unsuccessful in bidding on sites with favorable attributes for salmon production. Thus, to increase the production of its most successful output category (4-5kg) the company has been looking to replace its portion size trout production with large size trout and outsource plate size trout production to other farms in the UK. Portion trout has a low but stable profit margin of around 2% compared to large trout where the margin can be as high as 40%. Though there is considerable uncertainty around forecasting of margins for trout raw materials and different processed product lines.

The company has also invested in upgrading its processing facilities, improving efficiency and the capacity to process multiple lines of products. Additional amounts of salmon, portion size trout, sea bass and seabream are purchased from external suppliers and processed by the company, to fully utilize the capacity of the processing plant.

However, the large number of products, some 300 products in 2017 (pers comm), has also led to cost inefficiencies due to the frequent need to re-adjust production lines. Often processing lines must be stopped – cleaned – ran for a new product for as little as 30mins – stopped/ cleaned again and reverted. This makes it difficult to estimate unit cost, on the basis of which strategic decisions could be made. Although some products were said to be profitable, the company as a whole has not recorded a profit for the period examined, neither on the farming operation nor the company as a whole, (Figure 5-5). The key to its survival has been its ownership and private investment by one of the richest families in Scotland.

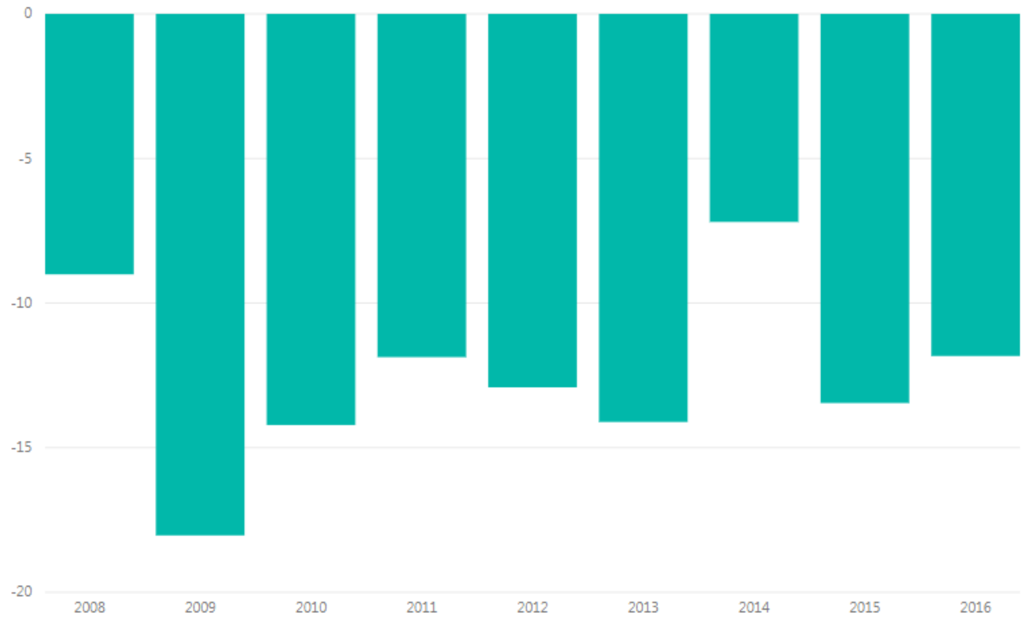


Figure 5-5. Company B's profit margin (%). Source: FAME (2019)

5.3.3 Company C: salmonid value-added processor

Company C was established in Scotland in the early 1990s as a salmon smoking operation. In 2012 it became a subsidiary to an Asian seafood conglomerate. In 2016 about permanent 200 staff workers were being employed and the company had an annual turnover of nearly £49 million. The company ceased its operations in 2018 due to persistent unprofitability.

Unlike the companies previously described, company C was not vertically integrated, but its operations were organised around salmonid processing only. Attempts have been made to upgrade the company's value chain by acquiring a farming unit, however, like company B the company was been outbid in the process by a large salmon producer.

Company C consisted of two processing units within the company – a small primary processing (gutting and packing fresh on ice) unit and a much larger value-addition processing unit. The primary processing unit consisted of around 20 employees and operated on a contractual basis with salmon farmers. The fish were gutted manually and packaged on ice. However, the main focus of company C was its value-added processing (VAP) partly under its own brand which was where the majority of output was generated, and labour employed. In 2016 the main source of raw material for the VAP processing unit was the Scottish salmon industry (about 75%) and the rest from Norway. In Scotland, their suppliers of raw material included all salmon producers, except for the smallest one (Company A). A key feature of its supply arrangements, which has had a detrimental impact on profitability however, included continuous re-negotiation of quantities and prices which were linked to the spot market prices for salmon, and as such resembled an auction market arrangement.

The company was manufacturing a wide variety of secondary-processed products of the ‘ready to cook’ and ‘ready to eat’ category and was able to produce according to customer specifications. In 2016 the approximate distribution of production was 75% raw salmon (fillets, portions, value added uncooked), 15% smoked and 10% cooked. In addition to salmon there was a small amount of portion trout (300-500g) being processed into gutted fish and fillets either fresh or smoked. The company used to mainly supply the domestic UK market and a much smaller proportion of its products were exported to continental Europe. In the last years before its closure the company supplied only multiple retail chains, with products marketed under the retailers’ private labels. There have been plans to develop own brand of products in order to derive more value out of processing, and it is a possibility for the future, however the focus had been placed on becoming a leader in supplying products under the retailers’ own brands. Its main customers in the UK were the discount / low cost retail chains. Its single largest customer has been Asda, where they have positions in both the high-end range as well as the value range, with the middle price range being occupied by Young’s; in 2016 they also signed contracts with Aldi and Lidl. In the past the company used to supply small quantities to restaurants, but they found that it was uneconomical because of the small size of orders and the special and different requirement of restaurants, which prevented it achieving economies of scale. An important supply contract with the food service chain was lost in 2017 to a major competitor.

Unlike the procurement of raw material, the supply to multiple retailers was done under strict contractual arrangements including specifications on prices and quantities. In addition, buyers would also impose many other requirements with regards to product form and conditions of processing against which they would regularly audit the company.

The shortcomings of this strategic position started to become clearer when in 2016 the company saw fairly heavy losses, as it found itself unable to pass on high raw material prices to customers. That resulted in an operating loss of £7m - compared to a £1.1m profit for the previous period, Until that year, buying raw material at spot market prices had not been seen as a problem, but fixed price contracts were starting to be considered to prevent further loses.

The nature of raw material procurement had also presented the challenge of coordinating the requirements of customers for timing of delivery and quality with what was available on the fish farms in terms of supply. With its strategic position, the company's main operational challenges were ensuring the continuity of supply of raw material, at times when it is needed. This was further complicated by the requirements from buyers regarding the reputation of the farms from which the raw material could be procured – e.g. they would ask the company to avoid buying from certain farms who are known to have bad reputation.

Under the ownership of a large international corporation, the company management felt that there was better access to financial resources, in both upgrading the processing technology, and in increasing the resilience of the company when losses occurred. In 2012 £3 million was invested in expansion of processing capacity and increasing the efficiency of the production processes. However, the main innovation focus was in decreasing the cost (and thus the price) of products. Nonetheless, in 2018 the Asian owner took a decision to divest the business stating that it has been suffering heavy losses as a result of a "highly challenging market".

5.4 Discussion

A study of the determinants of profitability in salmon aquaculture has been done by Asche, Sikveland and Zhang (2018) who used accounting data from a large sample of companies in Norway to generally conclude that larger volume sales positively affect profitability, in agreement with the findings of this study. While the analysis here did not exhaustively cover all SMEs in the salmonid value chain, it had covered issues beyond the firm, such as buyers' and sellers' bargaining power, nature of competition and substitution. The competitive forces in an industry to a great extent define the potential for profitability for actors in that industry and some industries are inherently more profitable than others by virtue of their industry structure (Porter, 2007). Different authors have arrived at different conclusions regarding the extent to which external and internal factors explain differences in firm profitability. For example, firm-related factors accounted for 47% in Rumelt's (1991) study, and industry-related factors - for 7% (46% is unexplained), while McGahan and Porter (1997) reported a larger industry effect of 19% (firm effects account for 31% and 50% is unexplained) using the same sample but adding service industries to manufacturing. What is clear, is that both external and internal factors play a role in defining profitability.

Common issues in the salmonid value chain pointing at the key factors affecting profitability began to emerge, namely value chain relationships and the nature and extent of rivalry between competitors within the industry. These two aspects were interrelated and reinforcing each other in shaping the profitability potential in the industry as a whole. For example, these are expected to be the reasons for the lower profitability of salmonid processing companies, which is a relatively fragmented industry, selling directly to powerful multiple retail chains (Noble, Quintana and Curtis, 2016). However, profitability differences between companies within the same industry are associated with strategic positioning. Successful strategic positions showed an alignment between the opportunities and challenges in the environment and the resources and capabilities of the company. Inversely, unfavourable strategic position could be linked to a mismatch between the resources of the company and its strategic goals.

Large size and vertical integration have become a threshold requirement for entering into marine salmonid aquaculture. Even though the companies studied here can be classified as SME's, they were the upper end of this category, bordering on the Large category. The smallest size enterprises that had existed in the '80s and '90s are not part of the industry anymore. In net-cage aquaculture and seafood processing, efficiency is a main competitive advantage. This is linked to company size and associated economies of scale. However, evidence of price competition was encountered in all of them. This was most clear in the selection of distribution channels, which in all three cases included multiple retailers positioned as 'low-cost' and 'discounters'. Low cost is a main competitive advantage in these outlets. However, that can rarely be achieved by an SME. The choice of distribution channels requires careful evaluation in the context of the strategic position of the company. Supplying multiple retailers is a strategy more suitable to large-scale suppliers, who can ensure the volumes and consistency demanded by the retailers. Consideration of the balance of power between suppliers and buyers is a major element of strategic positioning.

The shift in distribution channels from domestic multiple retailers to high-end restaurants and specialised shops in the UK, that was seen in Company A, and the expansion through exports, in combination with strengthening its focus on quality and branding, was a move more consistent with the resources of the company. While the production capacity of the firm was large compared to the average EU aquaculture producer, in the context of the major players in the Scottish salmon production business the company was a small one accounting for around 1% of the value of salmon in the country and about 1/50 of the production of the largest company in the sector. An examination of the structure of the salmon production industry in the previous chapter revealed a high level of concentration and large average company size. As a small company in a consolidated industry, Company A moved away from competing directly with its larger rivals and has chosen instead the path of differentiation.

Own brand was developed in the case of company A, which exploited its tangible and intangible resources to develop a brand identity. Financially constrained to major expansion, the firm has focused on developing its brand and marketing strategy to obtaining a premium price for its products stressing provenance attributes in its marketing-mix. While the 'traditional' farming facilities and methods may be seen as a disadvantage in terms of productivity, they are in line with the location of the farming sites, small bays, sheltered location and the leasing arrangements of the sites (general lack of security in investment). Moreover, the company has realised the value of these aspects as resources for brand building, turning a technological disadvantage into a marketing advantage.

The focus on low levels of value addition of this company was also in line with the demand characteristics of its distribution channels. Deciding to move up the value chain and produce value-added products (e.g. ready to eat, transformed etc), similar to it's larger and vertically integrated rivals, would necessitate channelling products into a different set of buyers and significant investment, while carrying the risks of entering a competitive environment for which the company has little resources and capabilities to compete effectively. On the other hand, some simple processing operations (such as smoking) which do not require large scale and sophisticated equipment, might provide opportunities for further value addition, particularly in combination with a strong brand.

Although having a comparable grow-out capacity as company A, company B has the position of being a leader in trout production in the UK. In the context of a stagnant trout market and a declining industry, company B, has employed an innovative approach in its effort to revive consumers' interest in trout. To that end, the company has adopted a business model which borrows significantly from the much more successful salmon industry. Increasingly, competitive advantage in seafood on the UK market lies in the ability to produce value-added products which save time and effort in preparation and cooking, and better complement a modern lifestyle. This is one of the primary reasons why small-size fish have lost popularity – there are limited options for value addition and extending the range of products sold through multiple retailers. The scope for value addition is broader when starting out with a generic processing raw material, which can be derived from large size fish.

The strategy of producing products similar to the more popular salmon and the move away from traditional trout products and image, has opened up the new market opportunities through value addition and reaching a broader customer base. However, the company has entered a competitive position in which its competitors are the much larger companies in the consolidated and integrated UK salmon sector. Thus, it has also exposed itself to new external forces, which the company's resources have thus far proved insufficient to counteract effectively, namely competition on price with salmon and the high bargaining power of large buyers. The effect of its strategic position was that it does not reach sufficient differentiation from salmon and, competing in the same outlets as a relatively small producer, it does not benefit from strong bargaining position. Eventually, instead of being the largest company in its market segment, company B's position resulted in being a small producer in a broad salmonid market. Thus, notwithstanding the differences in vertical integration and processing capacity with company A, company B's profitability was eroded by the same external forces as Company A before its strategic readjustment into farming. Moreover, its unfavourable bargaining position against buyers, resulted in a fragmented production, where the large number of products lead to processing inefficiency. According to Landazuri *et al.* (2020) there is no apparent productivity argument for the continued production of rainbow trout in marine net cages vis-à-vis Atlantic salmon. However, according to the same authors, there may exist a fringe of consumers that prefer its characteristics, motivating firms to maintain its production as a means of diversification, although it appears insufficient to detach fresh and frozen large trout from the Atlantic salmon market.

Unlike A and B, company C showcased a business model focused on a single activity (salmon processing) at a time of increasing consolidation in the salmon value chain in the UK, both horizontal and vertical. Not only are companies in the farming stage of the chain becoming bigger through mergers and acquisitions, but also increasingly vertically integrated i.e. incorporating other activities such as processing.

As evident from its's range of customers, company C had attempted to establish and maintain a position of a low-cost supplier. This strategic decision, however, was not successful in the long term, because the company's resources were insufficient to achieve this position in the context of competition from much larger and vertically integrated producers. Being neither a large company nor a vertically integrated one, through its choice of suppliers and buyers, company C had positioned itself in the unfavourable position between suppliers and buyers with high bargaining power. Because of its position in the value chain and its size, the company could not achieve a competitive advantage in the continuity of supply, which is a key success factor on the multiple retail market. Similarly, by positioning itself as a low-cost supplier but not ensuring a low and fixed price for its raw material, the company's profit margin was directly eroded by upward fluctuations in the salmon prices. This finding stands in contrast with the conclusion by Asche, Sikveland and Zhang (2018) that small companies benefit from fluctuation in salmon prices, derived from accounting data from Norwegian farms, however, it supports the hypothesis of Gizaw, Myrland and Xie (2020) contracts for the supply of value-added products obstruct price transmission in the salmon value chain. Price transmission for processed products along the value chain as compared to commodity products has been found to be less complete (Asche *et al.*, 2014). The competitors of company C were increasingly the salmon producers themselves, who are vertically integrated and unlike company C, benefit from the advantage of having their own supply of raw material. Moreover, by sourcing raw material from its rivals the company places itself in a vulnerable position in which it is exposed to attacks by its rivals.

While supply to multiple retailers was done on a contractual basis, there is strong competition between processors for winning a contract, when these are re-opened. Thus, the trends of consolidation in both the aquaculture and retail nodes of the value chain have with time changed the key success factors and made the company's position unfavourable. With the evolution of the upstream and downstream industries, increasingly the success factors in salmonid processing have become a combination of large operational size to ensure economies of scale and scope, as well as a leverage against the high bargaining power of buyers allowing focus on few product lines, and stable and secure supply of raw material, which favours downstream vertical integration. Individually, these are not sufficient, as illustrated by the case of company B.

The issue of disbalance in power between suppliers and buyers has been implicated in all three cases. This is a particularly important issue when it comes to SMEs (Dobson *et al.*, 2001; Washington and Ababouch, 2011). To improve its strategic position, a company should find suppliers and buyers who possess the least power to influence it adversely. Even if a company sells to a single industry, segments within the industry usually exist which exercise less power. In the case of company A this was the boutique restaurant and shops and export destinations that are less price sensitive than large retail chains. A company can still sell to powerful buyers and still achieve above average profitability it if is a low-cost producer or if its products are not easily substitutable i.e. enjoy some unique features. If these conditions are not present, selling to everyone becomes self-defeating because the more sales the company achieves, the more vulnerable it becomes (Porter, 1980). When choosing between buyers is not possible, strategic action that changes the dynamic factors that create buying and selling power is an alternative route to establishing a more favourable position. A supplier is powerful when the industry it belongs to it is dominated by a few companies and is more concentrated than the industry it sells to; its products are unique or at least differentiated, or if there are high switching costs (e.g. when the buyer has invested in adapting to the particular seller's products). Also, the bargaining power of sellers is high when they pose a threat of integrating forward into the buyer's industry or when the buyer is not an important customer for the seller. When it comes to the specific relationship between large retail chains and seafood suppliers, the most applicable of these options for the supplier are usually differentiation or concentration. This, part explains the high level of concentration in the salmon industry, whose main buyers are the multiple retail chains.

While this study was limited to only one country and a single value chain, the lessons learned here can be applied to SMEs in similar contexts, namely increasing consolidation along the value chain, from production to retailing. Apart from salmon value chains in other parts of the world, which, as seen previously, are highly consolidated, perhaps the most similar non-salmon value chain in this respect is that of sea bass and bream in Europe. The level of consolidation in the aquaculture node of this value chain is growing, while the dominance of retailers on the Mediterranean market is increasing. Therefore, SMEs in this value chain (particularly in the aquaculture node, since value added processing for these species is still limited) are increasingly exposed to the same forces as in the UK salmon value chain and are in the need of adjusting or re-establishing their strategic position is growing. The need for re-focusing strategy towards market orientation for the entire industry has been highlighted by Wagner and Young (2009), however, this pressure would be even higher for SMEs provided that competition has increased not only from larger companies within the industry but also from the growing dominance of low-cost producers in third countries such as Turkey. It is likely that long-term survival for these types of enterprises would increasingly be linked to differentiation from a commodity, where low price is the basis of competition, into a niche product supporting higher profit margins.

5.5 Conclusions

This study has uncovered the profitability patterns in the UK salmonid value chain and, through company-level case study analysis, has highlighted some of the key factors in the external business environment and internal to the company which determine profitability. Profitability in salmonid net-cage farming was on average higher than in other links of the value chain but was also subject to the widest variation between years and across companies. SMEs in salmonid net cage farming had a lower average profitability level compared to large enterprises. All three company case studies have pointed to competition from much larger and better resourced companies in the grow-out node of the value chain, as well as the high bargaining power of multiple retailers, as the main sources of pressure on the profitability of SMEs. The case of a trout farming company aiming to reverse declining UK demand for trout by growing fish to a large size has indicated some of the dangers of entering an industry with fundamentally different structure. It has pointed at the need for defining clearly the boundaries of the market in which the company is competing in order to establish an effective competitive position and avoid misevaluation of the resources required to compete. Differentiating from a commodity-type product through the development of a strong brand and emphasis on quality, as well as the selection of buyers whose bargaining power is comparable to that of the supplier, were the key success strategies that have allowed an SME to survive in the increasingly consolidated and productivity-oriented business of salmon farming. The case of a salmon processor positioned unfavourably between supplies and buyers has highlighted the importance of considering threshold resource requirements for successful competition in a selected market segment. Avoiding direct competition on price with larger competitors, who are more able to achieve lower cost position, and reducing the risks to profitability associated with the multiple retail channel should be some of the key strategic considerations of SMEs. Given that other aquaculture value chains in Europe and globally, such as seabass and seabream, are undergoing similar trends, the lessons learned in this analysis could be applied to those contexts, too.

Chapter 6: Product innovation and growth: cross-case study of ten novel seafood products on the EU market

6.1 Introduction

Aquaculture is seen by the European Commission (EC) as a strategic industry, whose sustainable growth should be strongly supported (European Comission, 2013). However, as indicated in the previous chapters, eventually the industry life cycle reaches a mature phase where growth slows down. Maturity is not fixed and can be delayed by innovations which regain rapid growth and more than one transition to maturity is possible (Levitt, 1965). Major growth in an industry in which the key success factor is economies of scale, such as aquaculture, tends to also be associated with consolidation. The research in this chapter is based on two implications that follow from this reasoning. The first one is that, if major growth is not possible, value addition by processing imported or domestically produced raw material may be sought as an alternative means to economic growth. Moreover, growth in the downstream consumer-facing links in the seafood value chain can indeed stimulate growth in the aquaculture industry itself. The benefits of product innovation include expanding the demand for raw material by creating a 'market pull' (Traill and Grunert, 1997). As indicated in Chapter 3, market development is an essential component of the sustainable growth of aquaculture in the EU, since many of the species produced in EU aquaculture are only regionally or locally traded and constrained by stagnant or declining demand. Processing and value addition allow new attributes to be added to the product, enhancing the value proposition and exposing the product to a new set of customers or attracting more purchases from the same set of customers, and in cases when successful, stimulate demand. The success of the salmon aquaculture industry has been driven to a large extent by the versatility of salmon as a raw material that can be processed into a wide range of products and thus enter numerous market segments (Landazuri-Tveteraas *et al.*, 2018). At the company level, innovation provides a means for differentiation from competition, growth and increased profitability (Asche, Cojocaru and Roth, 2018). Thus, stimulation of post-harvest product innovation provides an alternative route for reaching the objectives of growth, or at least supressing decline, in aquaculture output. Similarly, innovations in feed manufacturing, genetic selection and other upstream activities could translate to changes in the features of raw material and therefore in the end consumer product. The creation of value and ensuring growth therefore is a joint project of all partners of a value chain.

Thus, SMEs that are excluded from a mature and consolidated value chain can contribute to value creation in other links of the value chain, especially processing. In 2017 the overall number of enterprises in the EU carrying out fish processing as a main activity was around 3 500 firms, the vast majority of which were SMEs (Malvarosa, Carvalho and Guillén, 2019). The overall turnover produced by the sector is estimated at EUR 32.5 billion while employment at 130 664 persons (corresponding to 118 110 FTE). The degree of specialisation (defined as the share of turnover deriving from the principal activity on the total turnover), of the EU fish processing enterprises was around 84%, higher than that observed in the overall EU food manufacturing sector (around 78%), indicating that the level of vertical integration in EU seafood is still low and the industry is composed of large number of companies only involved in processing. However, all the structural indicators (number of enterprises and employment) show a sharp decrease over the last two years (2017 vs. 2016) while, over the period 2008-2017 a decrease in the number of enterprises of -7% was present, versus an increase of +20% in the turnover of the sector (Malvarosa, Carvalho and Guillén, 2019), indicating that consolidation is taking place. Nonetheless, the number of SMEs in processing is much higher than in the mature salmon aquaculture industry.

Secondary processing and value addition, whether to generic substitutable raw materials or 'niche' species, presents opportunities for innovation without the requirements for significant investment and large scale, making it possible for SMEs to exist alongside larger rivals. While there is no consensus in the literature regarding the influence of firm size on its innovativeness (Grunert et al., 1997), SMEs are commonly considered tend to be 'market makers' while large companies tend to be imitators, if the potential market volume allows large scale production. It has also been argued that SMEs are more prone to innovate because of organisational and behavioural characteristics allowing them to react to market changes more quickly e.g. little bureaucracy, high commitment and motivation by managers, higher exposure to competition, lower innovation costs, higher R&D efficiency. In this respect fewer management layers linked to shorter decision-making processes and less resistance to change may give SMEs an advantage over large organisations in the area of product development (Alegre, Sengupta and Lapiedra, 2013) and enable the NPD process to flow more effectively in SMEs (Dahlander and Gann, 2010). Similarly, SMEs can gain competitive advantage, through using their managerial and structural flexibility to quickly adapt to a fast changing environment (Voss *et al.*, 1998; Entrialgo, Fernández and Vázquez, 2000; Bianchi *et al.*, 2010). Similarly, radical innovation may be more typical of small and medium scale companies because it does not fit with the pragmatic philosophy of larger companies which are looking for a systematic innovation process. However, due to their size SMEs face many challenges in comparison to larger enterprises. Problems, such as a lack of resources including external contacts, finance and owner or management organisational dominance can all stifle the NPD process within SMEs (van de Vrande *et al.*, 2009; Padukkage, Hooper and Toland, 2015). Due to the lack of economies of scale, SMEs may find it difficult to be low-cost producers which often leads SMEs to differentiate, instead of competing on price basis (Voss *et al.*, 1998).

In any case, research has highlighted the importance of the ability to innovate and launch new products and services is vital to the survival of both large and small companies (McAdam, Reid and Shevlin, 2014). However, food product innovation efforts are not always successful with commonly reported figures for new food product failure are between 70% and 90% (Stewart-Knox and Mitchell, 2003). Unsuccessful trials can be harmful to the business (Traill and Grunert, 1997). The aim of this study was to investigate innovation in seafood at the end-product level and understand what factors affect the success of innovation. The results are intended to inform both businesses and policy makers engaged with the seafood industry.

6.2 Results & Discussion

6.2.1 Trends in product innovation in the European seafood industry

6.2.1.1 Type of innovation

Analysis of the GNPD data over a 16-year period (January 2000 - December 2015) revealed that 22,406 seafood products meeting the Mintel definition were launched on the European Market, which accounted for around 4% of the total number of innovations in the food industry. For the same period, the average distribution by type of innovation was: 44% new variety, 37% new products, 12% new packaging, 3% new formulations, and 2% product re-launches[11].

The share of 'new products' in the total number of product innovations had declined over the period in favour of the other, less risky, categories of product innovation. The growing share of new packaging stands out in particular (Figure 6-1).

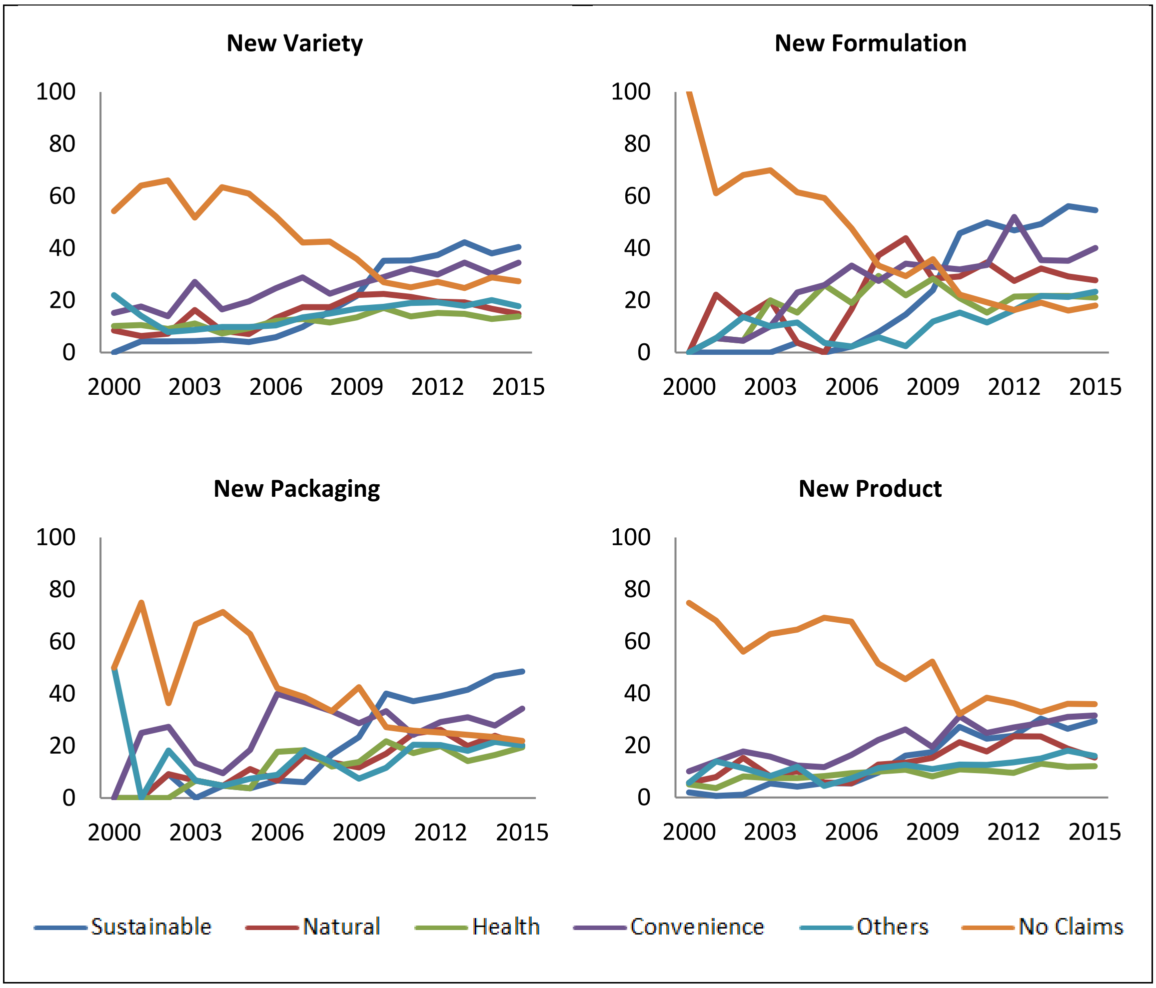
[11] Since new formulation and re-launch were not common strategies, these have been regrouped into New formulation category for further analysis

Source: Mintel International Group (2016)

Figure 6-1. Distribution of new seafood product launches on the European market by innovation category 2000-2015

6.2.1.2 Product positioning

Each type of innovation can be further broken down by intended market positioning. Effective positioning is achieved through marketing messages, or 'labels', which are addressed to specific market segments i.e. types of consumers. The labels analysed here relate to official third-party certification (such as MSC) as well as other 'self-claims' (e.g. rich in Omega-3). Here labels related to sustainability (e.g. MSC, ASC, organic, environmentally friendly), claims of convenience (e.g. ease of use and Microwaveable), natural production methods (e.g. No additives/Preservatives and GMO Free), health benefits (e.g. Antioxidant and Vitamin/Mineral Fortified, Omega-3) or other claims (e.g. Fair Trade, Kosher and Premium) are distinguished. The data point to a trend of increasing use of such marketing tools over the 16-year period: the number of seafood products without any claim has decreased from around 70% to 28% across countries and innovation types. The trend can be observed also within each category of new products (Figure 6-2). What can also be seen is that the total percentage grows over the period and exceeds 100% in all categories, which signifies that the number of products with more than one claim is growing. The trend of increasing number of claims as a result of evolving market for seafood attributes and growing competition was observed by Wessells (2002) and predicted to continue, in line with the findings here.



Total of 22,406 observations (New product: 8,657; New Packaging: 2,627; New Formulation: 1,228; New Variety: 9,894)

Source: Mintel International Group (2016)

Figure 6-2. Distribution of claims by type of launch (%) between 2000 and 2015

6.2.1.3 Innovations by firm

Between 2000 and 2015, 62% of seafood product innovations came from 'industrial brands' and, accordingly, the top 10 companies in terms of numbers of products introduced were for the most part large multiple-retail chains, with private label products (Table 6-1). Of all brand manufacturers, that were leaders in the seafood market, only Findus and Iglo reached the top ten. Iglo was more positioned on sustainability (almost 75% of its products) and naturalness (around 50% of its products). Findus was well positioned on convenience, in addition to sustainability claims.

Table 6-1. Top 10 firms by number of product innovations for the period 2000-2015

Firm	Percentage of products with at least one claim	Percentage of products with sustainable claim	Percentage of products with natural claim	Percentage of products with health claim	Percentage of products with convenience claim	Percentage of products with other claim
Iglo	90	74	53	16	33	18
Tesco	85	44	29	16	30	41
Asda	82	33	53	49	23	34
Marks & Spencer	80	57	23	16	42	16
Findus	72	49	21	13	41	9
Aldi	69	42	18	10	23	21
Picard	69	22	0	2	54	7
Auchan	62	20	9	2	30	29
Lidl	60	29	3	5	16	27
Carrefour	47	11	6	6	24	15
All companies	**64**	**28**	**18**	**13**	**28**	**16**

Total of 22,406 observations. Source: Mintel International Group (2016)

6.2.2 Findings from case study analysis

All cases investigated could be characterised as having medium to low level of originality. None of the products was truly new to the market and there was no major 'invention' present. In most of the cases 'newness' came from combining familiar concepts in a new way, e.g. new species of fish in an existing recipe. Here, 'borrowing' of ideas from the wider food industry was present to a considerable extent. Improvement or variations upon existing concepts was the other level of originality, e.g. new recipe. Combining improved concepts in a new way, provided yet another level of originality, e.g. new recipe for a sauce in a combination with a different species of fish. In terms of processes, in several of the cases improvements in existing processes or an application of technology in a new manner was serving as a basis for new product development. At the end, the products were improved to better suit the needs of the consumers (for example, using new technology for the removal of pin-bones from fish fillets), but were not radically new. The level of newness was important in determining whether a product would enter a new market or an established market. However, none of the products investigated were developed on the basis of imitating existing products, but in two of the cases the proucts investigated were 'copied' by retailers and reintroduced under new label, which was cited as a problem by producers.

The process of product development, and the success of new products, were largely shaped by factors internal to the firm, primarily linked to availability of resources and capabilities, including value chain activities. In addition, buyers, especially multiple retailers, appeared to play an important role in the process.

6.2.2.1 Internal factors

The greater access to financial resources allowed the large-scale firms (C, H and F) to adopt a highly specialised 'professional' approach to developing new products. This involved marketing experts and a systematic process of product development, including market segmentation, use of marketing intelligence, formation of a multidisciplinary team, and promotional activities. By being a large-scale firm with a significant contribution to local economy, in case C, the company had received support from an international development agency to develop products suited to the EU market in addition to its own efforts. This was because the company, being physically remote from the market, had reported difficulties accessing marketing information. Cooperative action by a large number of small-scale farms (case A), was also a strong basis for getting the necessary resources for innovation and build scale in processing, as well as to develop the distribution and logistics network of the company. In addition to in-house capabilities, several of the large firms had used external marketing and branding services. Importantly in this context, having undergone a formal market research process, large firms had a clear idea of the market segments they were targeting. The firms H and F targeted a large segment of customers and their strategy could be described as 'differentiation' from competition (Porter, 1985). Innovation in both cases was based more on branding than product features, pointing to the strong marketing capabilities in these firms. All the large-scale firm products examined claimed 'convenience' and 'sustainability'. Company C based its innovation on low price and the fact it was able to exploit production bases in a low-wage country. As such, it did not put an emphasis on branding, but rather emphasised sustainability, which is an important reputational criterion for accessing large retail chains with a pangasius product.

On the other hand, SMEs were managed partly or fully by the owners of the firm, except for the cooperative (A), which employed a manager. Thus, the management decisions were greatly dependent on the skills, capabilities, and attitudes of the owner-managers. The new product development process was usually based on market and customer experience of the owner and their 'intuitive' identification of market needs. This was followed by an informal process of product development, directed by the owner with the help of their management staff. In small firms, all staff, including workers, served as sources of ideas for new products. Externally, ideas also came from customers (retailers, distributors) or competitors. Small scale product testing and feedback was practised within the firm, with the families of the firms' staff and on local markets. Marketing and promotional activities were done directly by the senior staff members, often the owner, in face-to-face contacts with potential customers and participation in public events. Previous research has emphasised the need for adapting to a changing environment and evolving in order to survive (Cooper and Kleinschmidt, 1987; Stewart-Knox and Mitchell, 2003). While individual experience and organisational learning are important sources of creativity for all types of organisations (Petts, Herd and O'Heocha, 1998), there is a potential for increasing the share of professional marketing research and market intelligence systems in the process of new product development, particularly in the case of SMEs. There is a strong need for basing innovative activity on consumer demands i.e. adopting market orientation at the start of the process (Grunert *et al.*, 2009; Wagner and Young, 2009). Obtaining access to detailed market data and analysis, on which market orientation is based, can however, be cost-prohibitive for many SMEs. Nonetheless, this can still be achieved in cooperatives, with the help of public support to the industry, as is the case with the provision of market data through the Seafish Authority in the UK for example, or research projects like Primefish. To address this specific problem, a tool based on a regression model that calculates the best match between various consumer segments (obtained through market research) and hypothetical seafood product (attributes based on user input) was developed in Primefish and can be accessed free of charge[12].

Smaller firms in the sample tended to follow a 'focus strategy' (Porter, 1980), that targeted very small customer segments, which tend to be overlooked or ignored by larger competitors. Consistent with their core competencies, some small firms placed emphasis on 'artisanal', 'high quality', 'traditional', 'hand-made', 'local' as a way to differentiate their products. Other small firms also emphasised 'convenience' (E, B). Product positioning was not always communicated effectively in the case of SMEs, however. It depended on how well the target customer had been identified at the start. In one example of a failed product (Case B), the company admitted they did not have a particular customer group in mind, although positioning the product as 'healthy'. Similarly, in product G, the failure resulted from misinterpretation of perceived consumer needs. A retailer had asked the company to develop "quenelles" containing fish. The company's approach was to adapt this typical recipe from Rhone Alpes with fish from the north of France: herring. According to the company, most likely the product was a failure because the consumer didn't like its taste, which was very different from what quenelles usually have.

[12] http://dss.primefish.eu

Customer knowledge was gained more from close contacts with buyers than systematic research, which was an important determinant for the small firms' product innovation process, type and success. While small firms E and D had developed excellent contacts with direct consumers and intermediaries which complemented personal market and segment knowledge, companies B, A, C proceeded differently. Arguably, their vertically integrated structure also incorporating aquaculture farms – resulted in a more "production-oriented" rather than market-oriented to innovation i.e. motivated more by the availability of raw material, rather than an identified consumer need. This was observed in companies which had both raw material production (aquaculture) and processing capabilities within their value chains, whether small or large firms.

These firms were bound to the particular species they were producing and thus had limited scope for 'manoeuvre' to raw materials with attributes in higher demand. Nevertheless, new product development followed a general trend of development towards more convenience, health and value-addition. As such, their approach could be better described as a mix between production orientation and market orientation. For example, a vertically integrated owner-operated small trout company (B) was focused more on raw material production (fish farming). The expertise of its management was production-related, and the core competence of the company was in rearing fish. It produced only products based on the fish species it was growing in its farms. However, as noted by the firm's owner "We aim to follow the path of the chicken industry which developed more and more sophisticated products". In addition, while having a processing unit allowed for the development of a variety of products, such firms still did not have the flexibility that a 'processing only' plant had in terms of a market choice. Their 'path dependency' combined with small scale production limited them to only working with a species for which there was a flat or even a declining demand. The attributes of the raw material to a great extent determined the scope for value addition and the demand for the finished product. While firms A and B, engaged with processing of plate-size trout, were maintaining their market share through product innovation or growing slowly, their growth rate was much lower than that of firm C. Company C also started out as a small-scale farm, it was producing a product for the export market, integrated into a large whitefish market, for which at the time there was strong demand. This in turn allowed the company to quickly expand. It also significantly benefited from cost advantages, and flow of international capital by becoming listed on the stock market.

Aquaculture has the potential to be a more market-oriented activity than capture fisheries

(Young and Muir, 2008), as species choice and farming schedules allow more precise matching of market demand. In reality, for the vertically integrated firms examined here, the choice of species, and the size to which they can be grown, was limited by the surrounding environmental conditions and resource availability. Some systems (closed recirculation technology) allowed more flexibility in the choice of species than others, because the environmental conditions are controlled to a higher extent (e.g. case I). These systems however, are associated with a high level of investment risk (Murray, Bostock and Fletcher, 2014). The most predominant aquaculture systems in operation in the EU, forming the backbone of the EU aquaculture, however, are open and do not allow significant control of the environmental conditions (Bostock *et al.*, 2016). Thus, the raw material that can be produced in aquaculture as a basis for further processing, especially by small-scale firms, does not necessarily have the attributes that are in high demand. Yet, such production forms large part of the EU aquaculture sector (plate size trout, carp, as seen in Ch. 3) and is governed by production conditions. Therefore, inevitably, innovation efforts based on these raw materials would be to a great extent production oriented. However, that did not preclude firms from orienting their innovation to identified market needs. It indicated that growth may be more difficult with vertically integrated small production-oriented firms, if the company is bound to a raw material with attributes not in high demand. Vertical integration allows the firm to capture a larger share of the value of the product, which is necessary for the survival of small businesses. However, having production facilities can in some cases become a 'core rigidity' when the focus of activity is on value-added processing. For the small firm, differentiation and focus strategies (targeting of niche markets) by adding 'intangible' attributes to a product based on a well-established species can serve as a competitive advantage and to some extent counteract the limitations linked to the nature of raw material and its low potential for further innovation in the 'tangible' attributes. Moreover, each activity in the value chain requires a different set of skills. In many cases, the main capability of the firm remained in production, while processing, the most consumer-facing aspect of the business, was a secondary activity. The different capability requirements, as well as economies of scale and scope, may explain why secondary processing is usually decoupled from the production and primary processing stages of the seafood value chain.

Strong market-orientation was observed in firms which took satisfying a perceived customer need as a starting point for a new product development (F, H), or indeed, the initiation of the entire firm (I, D). The main activity of these market-oriented firms' value chains was seafood processing. Raw material was procured independently from other firms. The only exception (I) was a company whose product choice of exotic warm-water shrimp was selected for farming based on market demand. The product was marketed without further processing. Its key advantage was product’s freshness and the fact that it was ‘locally produced’, thus the farming itself was the consumer-facing activity. Marketing this product in its most natural state was seen as the main source of value and therefore the firm did not engage in further product development. While value-added products are usually considered products to which have undergone some level of processing, it is worth noting that under the term ‘value’ should be seen the perceived value to the consumer (Bowman and Faulkner, 1997), which does not always correspond to more processing. For some products, which are preferred by consumers fresh and unprocessed, processing would actually destroy value to some consumers (Carlucci *et al.*, 2015) and would be done in cases where the product cannot be marketed in the most preferred form e.g. where preservation is required to extend shelf life (Fuller, 2016). However, that will also cause a shift in the market segment and targeted consumer.

In case D, the in-depth knowledge of the market and consumer taste induced the founder to invent a new process to smoke salmon to fit the gourmet Italian consumer. This had successfully differentiated it from other, mainstream varieties already offered on the market.

Large-scale firms sought to expand their market in two different ways: by exports and by attracting new consumer segments with their current offer. Company H product line was designed to achieve market expansion by attracting young consumers, and ‘would-be fish eaters’ by a combination of convenience, innovative packaging and specially tailored marketing messages. Nation-wide TV advertising and strong social media marketing (penetration) supported this. Consequently, the firm expanded the product successfully with ‘variations’ around the concept to cater the segment of the young consumers. Company H also sought market expansion by modifying an existing product slightly to suit foreign tastes and exporting to EU countries. The firm had adopted a long-term growth view. While the largest group of seafood customers in the EU is currently the ‘middle aged’ and ‘senior’ citizens (Omar, Tjandra and Ensor, 2014), the company focused on targeting young adults, the customers of the future and markets with highest potential future growth, where it sought to establish a leading position. This view was also adopted by the cooperative in case A. In case C, the company’s almost entire production was for the export market, and while the EU and US markets were close to saturation, the company was developing presence in Asia, a fast-growing market with strong potential.

Both SMEs and large firms employed strategies for greater penetration of existing markets. Large firms, apart from C, involved promotional activities and national-wide advertising in association with new products in order to attract customers and strengthen their brand. On the other hand, SME's limited resources meant that market penetration activities were limited to local or domestic markets through direct contact of the owners with potential clients (B, G) or use of social media and company website. For example, company B engaged with potential buyers in local markets by providing samples of its products and, on a wider scale, promoted its products by taking part in cultural events and exhibitions.

6.2.2.2 External factors

In addition, product development activities were also strongly affected by factors external to the firm, namely multiple retail-chains and competition with other firms. Many of the firms interviewed, especially small producers, stressed the importance of influence of multiple retail chains on the success of their products and their potential for growth. Multiple retailers control access to a large proportion of the market, however, their requirements for high volume and continuity often mean that many SMEs are excluded from this distribution channel. The case of the farmers' cooperative (A) showed that by acting together firms were able to amass a critical volume of products and ensure continuity of supply and thus establish strong relations with a retailer. However, understanding the risks associated with having a single buyer, the firm nevertheless sought to diversify its customer base: "When the product became a success, we had a hard time expanding to other distributors as we couldn't manage to keep up with the orders [from the retailer]. In part that was good, but we didn't want to become dependent on only one distributor." Alternative channels were developed by some of the small firms (B, D, E), including local food service businesses and suppliers of local small shops. By diversifying their customer base, these firms also spread risk. Similarly, to avoid 'head to head' competition with larger firms providing similar products those firms chose alternatives to the retailers.

For the firms that supplied multiple retailers, a product can either be developed by the firm and presented to the retailer for approval or created under a retailer's request in the form of either a clear product description or a product concept, under which the firm was allowed to experiment. While most small-scale companies complained against the power of retailers, retailers also provided small companies with ideas and product requests, and thus allowed producers to benefit from their market knowledge (case A). Not all of such requests were successful, however. One of the failure products examined here (G) was one of them. It failed because the concept, although logical, did not understand the dynamics behind the consumption of the intended species.

Moreover, it was usually the decision of the retailer for how long to keep a product on their shelves. Even if a product is successful according to the firm developing it, the retailer may decide to delist it, as was reported by both large and small companies. In one of the cases (H), the reasons for this decision was linked to the replacement of the branded product with a similar product marketed under the retailer's own brand. This practice of 'copycatting' by retailers is not uncommon and can be detrimental to innovation, because the benefits of the innovation do not accrue to the firm introducing it, and deter future investment in innovation (Bunte *et al.*, 2011). The firm's response against this move was brand building. Larger leading firms saw brand building as a core element of their strategy. Expanding sales however have allowed the firm to create an alternative to retailing through its own direct-to-customer distribution through an online shop.

The influential role of multiple retailer chains in the success of seafood innovations and therefore, competitiveness of the sector as a whole, was strongly implicated in the analysis. While acting as distributors of the branded products, retailers also market their own private label brands, and as other businesses, they have their own competition strategies. As such they can be a 'double edge sword' when it comes to national brand products (Bunte *et al.*, 2011). External firms launching new products through a retailer have to be aware of and try to 'fit' the new product with the strategy of the retailer in order to be successful. Even if a new product has good potential, if it competes directly with the retailers' own brand products, it is unlikely it will succeed on the market. Moreover, while the evidence supports the idea that branded products are pushing innovation while retailers' own brands are 'imitating' (Bunte *et al.*, 2011), both, however, are contributing to a dynamic and competitive seafood industry. Retailers are able to elaborate and expand a concept to a larger scale and serve as 'brokers' of innovation to other manufacturing companies who produce for them. They can thus 'spill' the success of an innovation to a wider group of beneficiaries. And since a large proportion of the retail-multiple labels are 'value for money' type of products, low prices, achieved through saving on branding and marketing, this can result in expansion of the markets for those species and benefit producers overall. Also according to Porter (1998), a sophisticated customer base, such as the multiple retail chains in the EU, is one of the key determinants for an innovative and competitive national industry.

6.3 Conclusions

The findings of this study show that there is a growing emphasis on differentiation using labels and credence attributes to communicate tangible and intangible aspects of the product to consumers. The process of product development, and the success of new products, were largely shaped by factors internal to the firm, primarily linked to availability of resources and capabilities, including value chain activities. In addition, buyers, especially multiple retailers, appeared to play an important role in the process. Whether the innovation process starts from the market or from the raw material, the results indicate that successful projects identify a customer group whom to target their innovation to. Thus, to succeed with innovation, firms need to segment the market and match the requirements of their customers, whether retailers, restaurants or end consumers. Even though many of the new seafood products are not highly original and short-lived, because of imitation, innovation efforts ensure firm survival in an increasingly competitive environment, as well as contribute to market development and thus should be supported, particularly in the case of resource-constrained SMEs.

Chapter 7: General Discussion & Conclusions

The overarching question of this dissertation was how to achieve growth in the EU aquaculture sector. The question was approached by asking four sub-questions, each of which was the basis for the preceding four chapters. The aim of the following section was to relate the findings to the overarching question and discuss their implications to two broad categories of stakeholders – policy makers and businesses.

First, the research has highlighted that the potential for growth in aquaculture is not equal across industries within the same country and across the region. In order to increase the efficiency of public funding, a clear strategy and targeting are needed. The potential for growth depends on a dynamic interaction between the factors of production and market conditions. Therefore, for effective targeting and coordination, these factors need to be evaluated across all aquaculture industries, to establish the extent to they have potential for growth, considering the comparative advantages of locations (Cai, Leung and Hishamunda, 2009). For an industry in the early stages of the ILC, which has potential for major growth, the focus of funding should be placed on technology development to establish a dominant product-system configuration and on building scale (Porter, 1980). These stages are capital intensive, yet characterised by low profitability, which detracts many firms from making major investments (Verreynne and Meyer, 2010). Therefore, prioritising investment to projects that have high potential for contributing to industry growth but are constrained by capital requirements, supported by market development efforts (Asche, Cojocaru and Roth, 2018), could be recommended. On the other hand, if the potential for growth is not significant, the focus of investment would be more usefully placed on value creation and differentiation (Porter, 1980), acting also as means of protection against third country competition.

With regards to the sectoral-level factors that determine the growth potential and competitiveness of an aquaculture industry, the preceding chapter four has indicated that major growth in aquaculture output is the result of producing a standardised product (commodity) characterised by a large market, combined with economies of scale in production (Asche *et al.*, 2013). Species have become less important as an attribute in many commodity markets. The success of salmon and whitefish on the EU market is to a great extent can be attributed to the 'generic' nature of these commodities, and therefore access to a large markets (Anderson, Asche and Garlock, 2018). Therefore, when it comes to coordinating strategies and prioritising funding, the locations and systems of production, which are capable of producing a product whose attributes are in high demand, as well as holding potential for productivity growth and large-scale production, need to be prioritised and the obstacles for their exploitation removed.

Initial analysis suggests that the potential for major growth in freshwater EU aquaculture, even though comprising a large share of the total EU aquaculture output, is limited. Determined by scattered water resources, restrictive environmental protection policies, competition with other sectors such tourism and agriculture and climatic conditions, lead to a fragmented and small-scale industry (Bostock *et al.*, 2009), unable to match the high productivity per unit that is observed in tropical countries for example (Asche, Roll and Trollvik, 2009). All these factors, limit the scope for building the scale and productivity increase that can be observed in marine aquaculture (Asche *et al.*, 2013) and which is necessary for a major growth phase in the industry. The growth in trout aquaculture in Turkey (Landazuri-Tveteraas *et al.*, 2020) can be explained by the subsidies government has been giving to the industry, leading to price distortions and unfair competition with EU producers, for which a countervailing duty has been imposed on Turkish imports of trout (European Commission, 2020a). A certain level of productivity increase, however, and associated farm size growth and consolidation, in freshwater aquaculture can still be achieved, as demonstrated by Danish trout farming (Nielsen, Asche and Nielsen, 2016). In this case, a structural change in the sector towards fewer and larger farms has taken place, driven by environmental protection policies and technological innovation, which together have stimulated consolidation in the sector without reducing the annual volume produced in the country (Lasner *et al.*, 2017). Even though with this new technology trout farms can reach more than 1000 t of annual output (630t on average in 2011 as compared to 100 t for traditional farms), compared to the scale of marine net-cage aquaculture, this size category is still relatively small. The fact that aquaculture becomes more concentrated in all large producing countries suggests that there are also scale benefits in other parts of the value chain that large enterprise size allows to be exploited, such, as in the purchases of services, marketing and sales, research and development, complying with regulation and dealing with red tape (Olson and Criddle, 2008a).

Due to the nature of the aquatic resource, marine aquaculture provides better opportunities for building scale (Asche, 2008). Nevertheless, most countries cannot expect to develop much further their nearshore marine farming industry because of competition over use of space, prohibitive costs of marine sites and opposition from coastal communities (Hofherr, Natale and Trujillo, 2015). However, there is potential for offshore aquaculture development, particularly in the salmon industry which is pressed to move offshore because of disease issues and environmental impact, among others (FAO, 2017). Some of the largest salmon companies are already investigating potential technologies and designs of submersible net cages, converted cargo vessels, semi-closed submerged systems and others (Marine Harvest, 2016) some of which can overcome the limitations of mooring pointed out by Kapetsky, Aguilar-Manjarrez and Jenness (2013). Likewise, combining offshore wind farm turbines as fixation point for aquaculture has been given considerable attention by researchers (Wever, Krause and Buck, 2015). The average size of an offshore farming operation would likely exceed that of coastal farms (Soto and Wurmann, 2018). This fact limits the potential of small-scale offshore farming units and makes large-scale operations the only feasible option in the near future (FAO, 2017). Salmon, whose farming technology has been well developed for near-shore environments, is an obvious candidate for offshore aquaculture (Wever, Krause and Buck, 2015). However, other species with high potential to integrate into commodity markets in addition to salmon, include tuna, cod, amberjack, and to some extent seabass and seabream if these are farmed to a large size that allows filleting (Diversify, 2018). However, in the case where the species can be supplied in large quantities from capture fisheries, such as tuna and cod, aquaculture development needs to focus on improving the technology and reducing cost of production for these species in order to be a successful substitute for wild sourced products (Frampton, 2007).

Since there is no dominant offshore system design yet, which is typical for the embryonic stage of the industry life cycle (Klepper, 1997), this presents an opportunity for the EU to develop a first-mover advantage and secure a strategic position in an industry which is has not yet entered the stage of growth in its life cycle. There is a strong need for research and development in this respect and public funding can be utilised to develop feasible technologies, business models and administrative framework for offshore aquaculture to give a competitive advantage to domestic companies. However, to date, little public funding to aquaculture has been spent in this direction, with the vast majority dedicated to sectors which have little potential for growth and are already mature or stagnant (Guillen *et al.*, 2019).

Coordination across member states needs to account for the differential factors of production that give comparative advantage across species and locations, in other to prioritise development. Such factors include access to sea, coastline length, water temperature and temperature variation, extent of competition with other industrial sectors e.g. tourism. Data on these factors are available in through Geographic Information Systems (GIS) sources (Falconer *et al.*, 2018) and can be incorporated and harmonised with other tools in a coordinating and benchmarking toolbox in future research. Gomes Ferreira et al. (2020) integrated multiple data sources to develop an overall investor index for the EU aquaculture and operationalised it in the form of a software tool. The tool covers five broad categories of indicators (market, production, regulatory, environmental, and social). It carries the advantages of combining multiple competing factors into an aggregate index rating of the attractiveness of aquaculture for investors. However, the results do not indicate strategic actions for investment. Moreover, while the tool provides European country level advice, it treats aquaculture as a homogenous industry and does not uncover the broad species-system diversity that exists within the sector and across Member States (Bostock *et al.*, 2016). The research in the current thesis has attempted to address this issue, but further opportunities for improving the tool by expanding on other aspects relevant to competitiveness exist.

On the other hand, where the potential for growth seems to be low, i.e. the industry is in a mature or declining stage, according to the common ILC classifications (Klepper, 1997), or in a stagnant stage - a category which denotes an industry which is currently not growing but has not been through a major growth phase and associated shakeout and consolidation processes (Hamermesh and Silk, 1979) – alternative strategies need to be sought. The choice of strategy would vary with the resources and capabilities of the company (Teece, 2010).

In a mature stage, the competitive success factor is low cost which is not usually a viable strategy for a small company (Porter, 1980). In such cases, differentiating from larger competitors would be more appropriate (Verreynne and Meyer, 2010). In declining industries strategic alternatives include early exit, 'harvesting' the company's investment, shrinking selectively, holding the present position, and increasing investments to change the trajectory of demand (Harrigan, 1980). Levitt (1965) suggests two main strategies - "life extension" and "life stretching" - which a company can employ (pre-emptively, in advance) at various stages of the life cycle to manipulate the life-cycle of its products to keep sales and profit sustained rather than allowing the product to enter the usual stage of decline. This has been also used as the basis for the idea of constant re-inventing and 'creative destruction' are crucial for the sustained long-term growth of a company and avoiding the eventual decline of a product (Schumpeter, 1942).

A stagnant industry is much more similar to a declining industry in terms of the strategies that can be employed by companies (Hamermesh and Silk, 1979). The output of the industry in both volume and value is relatively small and fragmented into many small-scale producers. In contrast, the term mature is used to denote an industry that has been through a major growth phase, the contribution of the industry to the economy is significant and the output is concentrated in a few large-scale producers. According to Hamermesh and Silk (1979) it is still possible to do well and earn high returns in stagnating industries. The main strategies for successful competition relate to the identification and exploitation of growth segments within a generally stagnant market (e.g. large trout within generally stagnant trout market); shift in emphasis on product quality and innovativeness; and systematic improvement in the efficiency of the production and distribution system (Lilja, Sundberg and Sundberg, 2015). However, in many occasions the most appropriate strategy in such contexts would be “harvest” (i.e. cut investment to a minimum and focus on operate until economically feasible), typically followed by “divest” (Harrigan, 1980). Alternatively, finding new geographic markets, whether regional or international, where the demand characteristics match the existing product offering, presents an opportunity for expanding production.

Also, where growth potential does not seem to be high, broad sectoral policies, as well as company efforts, might be more effectively placed on value creation along the value chain. While this strategy might lead to economic growth, it does not increase self-sufficiency, however, which, as noted in the introduction, has been an important driver of the growth policy. Nonetheless, these practices are important in market development and for fair protection against third country competitors. With this in mind, the objective of self-sufficiency might need to be re-evaluated. International trade is not a zero-sum game and it is imports rather than exports that matter for a country while exports are important in order to pay for the imports a county needs (Krugman, 1995). Food self-sufficiency has gained attention as countries have sought to reduce their exposure to volatility on world food markets. However, it is widely critiqued by economists as a misguided approach to food security that places political priorities ahead of economic efficiency and the benefits for the importing country that arise from international trade (Clapp, 2017).

In any case, previous chapters have examined forms of value creation including altering the physical properties of the product through value-added processing. The results have indicated that successful NPD projects identify a customer group whom to target their innovation to (i.e. are market oriented) and align their firm resources and capabilities with the requirements of the external environment. The literature also highlights the importance of team work and the use of structured processes for innovation management (Cooper and Kleinschmidt, 1995; Cooper, 1999). Other researchers have emphasised the importance of product-related factors such as newness, sophistication, and product advantage, the NPD process, strategy-related factors, and market-related factors, such as competitive intensity and market potential (Henard and Szymanski, 2001), culture (Evanschitzky *et al.*, 2012), as well as marketing communication, including advertising and promotions (Gielens and Steenkamp, 2007).

In addition to that, however, use value can be created by adding intangible attributes to the product. This is particularly applicable to traditional products and in raw materials whose technological value for processing is not high and may be difficult to find new and unique tangible attributes to be added to the product (Cojocaru, Iversen and Tveterås, 2020). Increasingly, seafood product differentiation utilises intangible attributes, such as local production, protected origin (Aprile, Caputo and Nayga Jr, 2012) and on production methods (Leadbitter and Benguerel, 2014), such as through certifications schemes based on organic or sustainable and ethical practices (Mariojouls and Wessells, 2002; Olesen *et al.*, 2010). In fact, it has been found that in salmon aquaculture differentiation takes place mostly on the extrinsic factors (Cojocaru, Iversen and Tveterås, 2020). One strategic route to increasing the competitive edge of domestic producers is, thus, placing more focus the high standards of production in the EU, which can serve as a point of differentiation from imports with more generic attributes (Washington and Ababouch, 2011). Indeed, firms are increasingly recognising sustainability issues as an area of strategic interest, based the potential for “eco-efficiency” - the better utilisation of resources- or differentiation and exploitation of market niches based on developing more sustainable products and processes (Engle and Wossink, 2009; Orsato, 2009). However, there has been considerable (and ongoing) debate as to whether sustainability results in better profitability for the businesses engaging in it (Campbell and Slack, 2008). Porter and Kramer (2002) suggest that only where social and economic benefits converge with “corporate philanthropy”, is the engagement in sustainability initiatives really strategic.

Certification seems to be a strategy pursued by large aquaculture companies (Amundsen, Gauteplass and Bailey, 2019) as means to getting access to multiple retail chains who require these as a form of risk outsourcing (Bush *et al.*, 2013, 2019). However, there is a wide variety of standards (Alfnes, Chen and Rickertsen, 2018) which vary in focus, purpose and process of development (Nilsen, Amundsen and Olsen, 2018).

Moreover, differentiation is successful if it results in a price premium or improved market share (increased sales) compared to the baseline stock. Evidence suggests that for certain species there is a price premium is of between 10% and 14.5% as a result of MSC label (Roheim, Asche and Santos, 2011b; Sogn-Grundvåg, Larsen and Young, 2013, 2014; Asche *et al.*, 2015; Blomquist, Bartolino and Waldo, 2015). A higher premium of between 20% and 38% has been identified for smoked organic salmon (Aarset *et al.*, 2004; Asche *et al.*, 2015; Ankamah-Yeboah, Nielsen and Nielsen, 2016). Similarly, EUMOFA (2017) describes significant price premiums for organically certified seafood in the EU, but not always improved profitability. In addition, differentiation in seafood is often temporary and eroded by imitation (Sogn-Grundvåg and Young, 2013). The more stocks become certified, the more their uniqueness gets undermined. Thus, certified products may fail to generate adequate premium due to a low level of recognition by consumers and concomitant low willingness to pay. Also, differentiation-based competition strategy is fundamentally at odds with the aim of standards bodies to ever expand their customer base in order to maximise sustainability benefits. This means first mover (differentiation) advantage is often only temporary.

Also, certification can represent an additional cost to the farmer (Bush *et al.*, 2013). From a resource based perspective (Barney, 1991), potentials for profitability can be viewed as contingent on economic fundamentals of a specific business i.e. "the structure of the industry in which the business operates, its position within that structure, and its organisational capabilities" (Reinhardt, 1998). In other words, some companies will be better positioned to profit from sustainability initiatives than others whilst not all sustainability initiatives will result in an economic benefit. Smaller firms may also be less inclined to believe that that their efforts can significantly lower negative environmental impact or that they will gain significant commercial benefit from tackling such issues. For some firms, large or small environmental certification may be considered overly bureaucratic, too costly or they may have established an independent reputation and relations with their buyers with their own internal quality assurance systems (Waite *et al.*, 2014). An area for future research on SME certification, therefore, includes the factors that determine the scope for mutual benefit.

7.1 Conclusions

In order to increase the chances of achieving the overall growth objective for EU aquaculture and increase the efficiency of public resource use, a more targeted and coordinated approach to policymaking needs to be adopted. In the context of the Open Method of Coordination, a prototype EU-wide platform for identifying priority species, based on market potential, and then identifying which countries have the highest potential for achieving them as well as benchmarking member states' performance, has been developed here and presents an opportunity for improving the level of coordination, transparency and supporting strategy formulation. Further work needs to focus on expanding and integrating the platform with other strategy support tools. Also, the research has suggested withing the limitations linked to the generalisability of the case approach, the factors that are likely to be playing important roles in defining the potential for growth of aquaculture industries and which need to be part of the coordination process. For a major growth in aquaculture to occur, policies need to target the development of industries for the attributes of whose products there is strong demand, and which are likely to undergo major productivity growth. For industries which are in later stages of their life cycle strategic focus might be more usefully placed on value creation, along the value chain, and differentiation from lower-price substitute products. However, success or failure eventually remains with companies, and the research here has pointed at some of the important factors at play, which both companies and institutions distributing financial support need to take into account, namely the synergy between the company's strategic position, resources and capabilities and the success factors of the changing business environment. Also, market orientation, as an important element of successful new product development projects, has been highlighted. In this context, directions for future research, including further investigation of the factors determining success and failure of industries and enterprises, in the aquaculture value chain, have been identified.

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Appendices

9.1 Appendix 1: Conversion factors for HS codes

HS version	HS code	SH6_CF
H2	030191	1.00
H2	030192	1.00
H2	030193	1.00
H2	030199	1.00
H2	030233	1.00
H2	030240	1.00
H2	030264	1.00
H2	030266	1.00
H3	030721	1.00
H3	030731	1.00
H4	030711	1.00
H2	030624	1.00
H2	030721	1.00
H2	030731	1.00
H2	030791	1.00
H3	030191	1.00
H3	030192	1.00
H3	030193	1.00
H3	030194	1.00
H3	030195	1.00
H3	030199	1.00
H3	030233	1.00
H3	030240	1.00
H3	030264	1.00
H3	030266	1.00
H4	030191	1.00
H4	030192	1.00
H4	030193	1.00
H4	030194	1.00
H4	030195	1.00
H4	030199	1.00
H4	030233	1.00
H4	030241	1.00
H4	030242	1.00
H4	030244	1.00
H4	030256	1.00
H4	030271	1.00
H4	030273	1.00
H4	030274	1.00
H4	030721	1.00
H4	030731	1.00
H4	030771	1.00
H4	030781	1.00
H4	030811	1.00
H4	030821	1.00
H5	030191	1.00
H5	030192	1.00
H5	030193	1.00
H5	030194	1.00
H5	030195	1.00
H5	030199	1.00
H5	030233	1.00
H5	030241	1.00
H5	030242	1.00
H5	030244	1.00
H5	030256	1.00
H5	030271	1.00
H5	030273	1.00
H5	030274	1.00
H5	030631	1.00
H5	030633	1.00
H5	030634	1.00
H5	030639	1.00
H5	030711	1.00
H5	030721	1.00
H5	030731	1.00
H5	030771	1.00
H5	030781	1.00
H5	030782	1.00
H5	030811	1.00
H5	030821	1.00
H2	030350	1.00
H2	030374	1.00
H2	030376	1.00
H2	030621	1.00
H2	030710	1.00
H3	030351	1.00
H3	030374	1.00

H3	030376	1.00
H3	030621	1.00
H4	030325	1.00
H4	030326	1.00
H4	030351	1.00
H4	030354	1.00
H5	030325	1.00
H5	030326	1.00
H5	030351	1.00
H5	030354	1.00
H5	030691	1.00
H5	030693	1.00
H5	030694	1.00
H5	030712	1.00
H5	030719	1.00
H5	030784	1.00
H5	030812	1.00
H5	030819	1.00
H5	030822	1.00
H5	030829	1.00
H2	030551	5.09
H2	030559	3.91
H2	030561	1.46
H2	030562	1.92
H2	030563	1.33
H2	030569	1.82
H3	030739	4.50
H2	030729	7.58
H3	030551	5.09
H3	030559	3.74
H3	030561	1.46
H3	030562	1.92
H3	030563	1.33
H3	030569	1.81
H3	030759	1.28
H4	030551	5.09
H4	030559	3.41
H4	030561	1.46
H4	030562	1.92
H4	030563	1.33
H4	030564	1.86
H4	030569	1.80
H4	030791	1.14
H5	030551	5.09

H5	030552	2.57
H5	030554	2.66
H5	030559	3.42
H5	030561	1.46
H5	030562	1.92
H5	030563	1.33
H5	030564	1.86
H5	030569	1.80
H5	030729	6.22
H5	030759	1.28
H5	030779	1.36
H5	030787	1.36
H5	030788	1.36
H2	030110	0.00
H2	030211	1.06
H2	030212	1.14
H2	030219	1.14
H2	030221	1.18
H2	030222	1.07
H2	030223	1.04
H2	030229	1.07
H2	030231	1.15
H2	030232	1.13
H2	030234	1.10
H2	030235	1.16
H2	030236	1.15
H2	030239	1.15
H2	030250	1.31
H2	030261	0.77
H2	030262	1.14
H2	030263	1.19
H2	030265	1.34
H2	030269	1.14
H5	030111	0.00
H2	030741	1.47
H2	030751	1.23
H3	030110	0.00
H3	030211	1.07
H3	030212	1.14
H3	030219	1.14
H3	030221	1.18
H3	030222	1.07
H3	030223	1.04
H3	030229	1.07

H3	030231	1.15
H3	030232	1.13
H3	030234	1.10
H3	030235	1.15
H3	030236	1.15
H3	030239	1.15
H3	030250	1.31
H3	030261	0.77
H3	030262	1.14
H3	030263	1.19
H3	030265	1.33
H3	030267	1.24
H3	030268	1.70
H3	030269	1.12
H3	030751	1.23
H4	030111	0.00
H4	030119	0.00
H4	030211	1.07
H4	030213	1.14
H4	030214	1.14
H4	030219	1.14
H4	030221	1.18
H4	030222	1.07
H4	030223	1.04
H4	030224	1.10
H4	030229	1.07
H4	030231	1.15
H4	030232	1.13
H4	030234	1.10
H4	030235	1.15
H4	030236	1.15
H4	030239	1.15
H4	030243	0.77
H4	030245	1.06
H4	030246	1.17
H4	030247	1.24
H4	030251	1.31
H4	030252	1.14
H4	030253	1.19
H4	030254	1.39
H4	030255	1.16
H4	030259	1.13
H4	030272	1.12
H4	030279	1.12

H4	030281	1.33
H4	030282	1.17
H4	030283	1.70
H4	030284	1.09
H4	030285	1.06
H4	030289	1.09
H4	030741	1.47
H4	030751	1.23
H5	030119	0.00
H5	030211	1.07
H5	030213	1.14
H5	030214	1.14
H5	030219	1.14
H5	030221	1.18
H5	030222	1.07
H5	030223	1.04
H5	030224	1.10
H5	030229	1.07
H5	030231	1.15
H5	030232	1.13
H5	030234	1.10
H5	030235	1.16
H5	030236	1.15
H5	030239	1.15
H5	030243	0.77
H5	030245	1.06
H5	030246	1.17
H5	030247	1.24
H5	030249	1.05
H5	030251	1.31
H5	030252	1.14
H5	030253	1.19
H5	030254	1.39
H5	030255	1.16
H5	030259	1.13
H5	030272	1.12
H5	030279	1.12
H5	030281	1.33
H5	030282	1.17
H5	030283	1.70
H5	030284	1.09
H5	030285	1.06
H5	030289	1.09
H5	030635	1.15

H5	030636	1.15
H5	030751	1.23
H2	030311	1.30
H2	030319	1.30
H2	030321	1.16
H2	030322	1.16
H2	030329	1.18
H2	030331	1.30
H2	030332	1.07
H2	030333	1.05
H2	030339	1.09
H2	030341	1.14
H2	030342	1.15
H2	030343	1.13
H2	030344	1.12
H2	030345	1.10
H2	030346	1.11
H2	030349	1.15
H2	030360	1.50
H2	030371	1.20
H2	030372	1.40
H2	030373	1.51
H2	030375	1.34
H2	030377	1.18
H2	030378	1.45
H2	030379	1.34
H2	030614	2.58
H3	030311	1.30
H3	030319	1.30
H3	030321	1.15
H3	030322	1.16
H3	030329	1.18
H3	030331	1.30
H3	030332	1.07
H3	030333	1.05
H3	030339	1.09
H3	030341	1.12
H3	030342	1.15
H3	030343	1.13
H3	030344	1.10
H3	030345	1.10
H3	030346	1.12
H3	030349	1.14
H3	030352	1.50
H3	030361	1.15
H3	030362	1.70
H3	030371	1.20
H3	030372	1.40
H3	030373	1.51
H3	030375	1.33
H3	030377	1.18
H3	030378	1.45
H3	030379	1.33
H3	030614	2.58
H4	030311	1.30
H4	030312	1.30
H4	030313	1.16
H4	030314	1.15
H4	030319	1.18
H4	030323	1.12
H4	030324	1.12
H4	030329	1.12
H4	030331	1.30
H4	030332	1.07
H4	030333	1.05
H4	030334	1.10
H4	030339	1.17
H4	030341	1.08
H4	030342	1.14
H4	030343	1.13
H4	030344	1.05
H4	030345	1.11
H4	030346	1.15
H4	030349	1.11
H4	030353	1.20
H4	030355	1.11
H4	030356	1.33
H4	030357	1.15
H4	030363	1.50
H4	030364	1.40
H4	030365	1.51
H4	030366	1.45
H4	030367	1.61
H4	030368	1.20
H4	030369	1.36
H4	030381	1.33
H4	030382	1.33
H4	030383	1.70

H4	030384	1.18
H4	030389	1.41
H5	030311	1.30
H5	030312	1.30
H5	030313	1.16
H5	030314	1.15
H5	030319	1.18
H5	030323	1.12
H5	030324	1.12
H5	030329	1.12
H5	030331	1.30
H5	030332	1.07
H5	030333	1.05
H5	030334	1.10
H5	030339	1.17
H5	030341	1.08
H5	030342	1.17
H5	030343	1.13
H5	030344	1.05
H5	030345	1.11
H5	030346	1.15
H5	030349	1.11
H5	030353	1.20
H5	030355	1.11
H5	030356	1.33
H5	030357	1.15
H5	030359	1.08
H5	030363	1.50
H5	030364	1.40
H5	030365	1.51
H5	030366	1.45
H5	030367	1.61
H5	030368	1.20
H5	030369	1.36
H5	030381	1.33
H5	030382	1.33
H5	030383	1.70
H5	030384	1.18
H5	030389	1.44
H5	030614	2.58
H5	030615	2.40
H5	030616	1.40
H5	030617	1.28
H5	030722	6.36
H5	030732	4.50
H5	030752	1.28
H5	030772	5.28
H5	030783	5.00
H2	160411	1.52
H4	160559	1.36
H4	160561	1.00
H4	160562	1.00
H4	160563	1.00
H4	160569	1.00
H4	190220	1.00
H2	160412	1.43
H2	160413	2.02
H2	160414	2.16
H2	160415	1.79
H2	160419	1.89
H2	160420	1.71
H2	160510	1.80
H2	160520	1.66
H2	160530	1.08
H2	160540	2.40
H2	160590	1.90
H2	190220	1.00
H3	160412	1.43
H3	160413	2.02
H3	160414	2.16
H3	160415	1.79
H3	160419	1.89
H3	160420	1.71
H3	160510	1.80
H3	160520	1.66
H3	160530	1.08
H3	160540	2.40
H3	160590	1.90
H3	190220	1.00
H4	160510	1.80
H4	160521	1.66
H4	160529	1.66
H4	160530	1.08
H4	160540	2.40
H4	160551	1.36
H4	160552	6.83
H4	160553	2.61
H4	160554	1.36

H4	160555	1.36
H4	160556	1.36
H4	160557	1.36
H5	160414	2.17
H5	160419	1.89
H5	160420	1.71
H5	160510	1.80
H5	160521	1.66
H5	160529	1.66
H5	160530	1.08
H5	160540	2.40
H5	160551	1.36
H5	160552	6.83
H5	160553	2.61
H5	160554	1.36
H5	160555	1.36
H5	160556	1.36
H5	160557	1.36
H5	160559	1.36
H5	160561	1.00
H5	160562	1.00
H5	160563	1.00
H5	160569	1.00
H5	190220	1.00
H2	030410	2.01
H2	030490	0.70
H2	030541	2.10
H2	030542	1.81
H2	030549	3.14
H2	030611	1.95
H3	030629	1.00
H3	030710	1.00
H3	030729	7.58
H4	030626	1.28
H4	030627	1.28
H4	030629	1.47
H4	030719	1.18
H2	030612	1.85
H2	030613	1.28
H2	030619	1.88
H2	030622	1.63
H2	030623	1.15
H2	030629	1.00
H2	030739	4.50

H2	030749	1.37
H2	030759	1.28
H2	030799	2.78
H3	030541	2.10
H3	030542	1.81
H3	030549	3.14
H3	030611	1.95
H3	030612	1.85
H3	030613	1.28
H3	030619	1.88
H3	030622	1.63
H3	030623	1.15
H3	030624	1.00
H3	030741	1.47
H3	030749	1.37
H3	030791	1.00
H3	030799	2.78
H4	030541	2.10
H4	030542	1.81
H4	030543	2.11
H4	030544	2.26
H4	030549	3.85
H4	030611	2.10
H4	030612	1.95
H4	030614	2.38
H4	030615	2.04
H4	030616	1.48
H4	030617	1.34
H4	030619	2.13
H4	030621	1.70
H4	030622	1.77
H4	030624	1.27
H4	030625	1.70
H4	030729	7.13
H4	030739	3.87
H4	030749	1.37
H4	030759	1.31
H4	030779	3.86
H4	030789	3.18
H4	030799	2.12
H4	030819	2.33
H4	030829	2.33
H4	030830	2.00
H4	030890	2.00

H5	030456	1.00
H5	030459	1.10
H5	030539	3.14
H5	030541	2.10
H5	030542	1.81
H5	030543	2.11
H5	030544	2.26
H5	030549	3.85
H5	030553	4.30
H5	030611	1.95
H5	030612	1.85
H5	030619	1.99
H5	030632	1.00
H5	030692	1.95
H5	030695	1.15
H5	030699	1.00
H5	030739	4.50
H5	030742	1.35
H5	030743	1.36
H5	030749	1.28
H5	030791	1.00
H5	030792	1.00
H5	030799	5.00
H5	030830	2.50
H5	030890	2.33
H2	030420	2.70
H2	030530	3.26
H3	030419	2.03
H3	030421	1.83
H3	030422	2.20
H3	030429	2.73
H3	030530	3.26
H4	030431	2.48
H4	030432	2.30
H4	030433	2.50
H4	030439	2.48
H4	030441	1.60
H4	030442	2.03
H4	030443	2.77
H4	030444	2.72
H4	030445	2.60
H4	030446	2.63
H4	030449	3.19
H4	030461	2.86

H4	030462	2.30
H4	030463	2.50
H4	030469	2.22
H4	030471	2.85
H4	030472	3.06
H4	030473	2.55
H4	030474	2.37
H4	030475	2.95
H4	030479	2.80
H4	030481	1.80
H4	030482	1.94
H4	030483	2.74
H4	030484	1.83
H4	030485	2.20
H4	030486	2.05
H4	030487	2.50
H4	030489	3.10
H4	030531	3.76
H4	030532	3.55
H4	030539	3.14
H5	030431	2.48
H5	030432	2.30
H5	030433	2.50
H5	030439	2.48
H5	030441	1.60
H5	030442	2.03
H5	030443	2.77
H5	030444	2.72
H5	030445	2.60
H5	030446	2.63
H5	030447	2.62
H5	030448	2.55
H5	030449	3.19
H5	030461	2.86
H5	030462	2.30
H5	030463	2.50
H5	030469	2.22
H5	030471	2.85
H5	030472	3.06
H5	030473	2.55
H5	030474	2.37
H5	030475	2.95
H5	030479	2.80
H5	030481	1.80

H5	030482	1.94
H5	030483	2.74
H5	030484	1.83
H5	030485	2.20
H5	030486	2.05
H5	030487	2.50
H5	030488	2.60
H5	030489	3.29
H5	030531	3.76
H5	030532	3.55
H2	160416	2.00
H3	030411	1.30
H3	030412	1.32
H3	030499	0.70
H3	160411	1.52
H3	160416	2.00
H4	030451	1.00
H4	030459	1.10
H4	030493	3.08
H4	030494	3.09
H4	030495	0.68
H4	030499	1.27
H4	030571	10.00
H4	160411	1.52
H4	160412	1.43
H4	160413	2.02
H4	160414	2.16
H4	160415	1.79
H4	160416	2.00
H4	160417	1.64
H4	160419	1.89
H4	160420	1.71
H5	030292	10.00
H5	030392	10.00
H5	030451	1.00
H5	030457	2.55
H5	030493	3.08
H5	030494	3.09
H5	030495	0.68
H5	030496	1.00
H5	030497	2.55
H5	030499	1.27
H5	030571	10.00
H5	160411	1.52

H5	160412	1.43
H5	160413	2.02
H5	160415	1.79
H5	160416	2.00
H5	160417	1.64
H5	160418	10.00
H2	030270	0.00
H2	030380	0.00
H2	030510	0.00
H2	030520	0.00
H2	051191	0.00
H2	121220	0.00
H2	150410	0.00
H2	150420	0.00
H2	150430	0.00
H2	160300	0.00
H4	210410	0.00
H4	210420	0.00
H4	230120	0.00
H2	160430	0.00
H2	210410	0.00
H2	210420	0.00
H2	230120	0.00
H3	030270	0.00
H3	030380	0.00
H3	030491	0.00
H3	030492	0.00
H3	030510	0.00
H3	030520	0.00
H3	051191	0.00
H3	121220	0.00
H3	150410	0.00
H3	150420	0.00
H3	150430	0.00
H3	160300	0.00
H3	160430	0.00
H3	210410	0.00
H3	210420	0.00
H3	230120	0.00
H4	030290	0.00
H4	030390	0.00
H4	030452	0.00
H4	030453	0.00
H4	030454	0.00

H4	030455	0.00
H4	030491	0.00
H4	030492	0.00
H4	030510	0.00
H4	030520	0.00
H4	030572	0.00
H4	030579	0.00
H4	051191	0.00
H4	121221	0.00
H4	121229	0.00
H4	150410	0.00
H4	150420	0.00
H4	150430	0.00
H4	160300	0.00
H4	160431	0.00
H4	160432	0.00
H5	030291	0.00
H5	030299	0.00
H5	030391	0.00
H5	030399	0.00
H5	030452	0.00
H5	030453	0.00
H5	030454	0.00
H5	030455	0.00
H5	030491	0.00
H5	030492	0.00
H5	030510	0.00
H5	030520	0.00
H5	030572	0.00
H5	030579	0.00
H5	051191	0.00
H5	121221	0.00
H5	121229	0.00
H5	150410	0.00
H5	150420	0.00
H5	150430	0.00
H5	160300	0.00
H5	160431	0.00
H5	160432	0.00
H5	210410	0.00
H5	210420	0.00
H5	230120	0.00

9.2 Appendix 2: Main commercial species in aquaculture

Main commercial species	*'Aquaculturable'*	*Farmed in the EU*
Abalone	Yes	Yes
Alaska pollock	No	No
Anchovy	No	No
Blue whiting	No	No
Brill	No	No
Carp	Yes	Yes
Caviar, livers and roes	Yes	Yes
Clam	Yes	Yes
Cobia	Yes	No
Cod	Yes	No
Crab	No	No
Cusk-eel	No	No
Cuttlefish	No	No
Dab	No	No
Dogfish	No	No
Eel	Yes	Yes
Fish oil	No	No
Fishmeal	No	No
Flounder, European	No	No
Flounder, other	No	No
Freshwater catfish	Yes	Yes
Freshwater crayfish	Yes	Yes
Grenadier	No	No
Gurnard	No	No
Haddock	No	No
Hake	No	No
Halibut, Atlantic	Yes	Yes
Halibut, Greenland	No	No
Halibut, other	No	No
Herring	No	No
Horse mackerel, Atlantic	No	No
Horse mackerel, other	No	No
Jellyfish	No	No
John dory	No	No
Ling	No	No
Lobster Homarus spp	No	No
Lobster, Norway	No	No
Mackerel	No	No
Megrim	No	No
Miscellaneous fin-fish, n.e.s.	No	No
Miscellaneous small pelagics	No	No
Molluscs and aquatic invertebrates, other	Yes	Yes

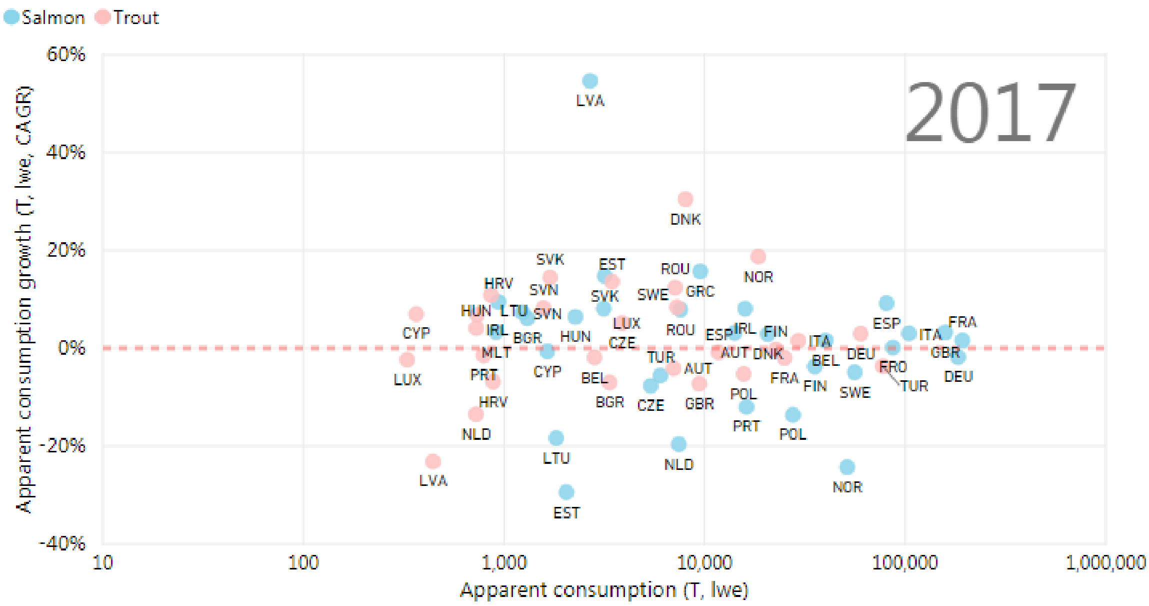
Monk	No	No
Mussel Mytilus spp	Yes	Yes
Mussel, other	Yes	Yes
Nile perch	No	No
Octopus	No	No
Other cephalopods	No	No
Other crustaceans	No	No
Other flatfish	No	No
Other freshwater fish	Yes	Yes
Other groundfish	No	No
Other marine fish	Yes	Yes
Other non-food use	No	No
Other products	No	No
Other salmonids	Yes	Yes
Other sharks	No	No
Oyster	Yes	Yes
Pangasius	Yes	No
Picarel	No	No
Pike	Yes	Yes
Pike-perch	Yes	Yes
Plaice, European	No	No
Plaice, other	No	No
Pollack	No	No
Pouting (=Bib)	No	No
Ray	No	No
Ray's bream	No	No
Red mullet	No	No
Redfish	No	No
Rock lobster and sea crawfish	No	No
Saithe (=Coalfish)	No	No
Salmon	Yes	Yes
Salmon Atlantic/Danube	Yes	Yes
Salmon Pacific	Yes	Yes
Salmon Sockeye	Yes	Yes
Sardine	No	No
Scabbardfish	No	No
Scallop	Yes	Yes
Sea cucumber	Yes	Yes
Sea urchin	No	No
Seabass, European	Yes	Yes
Seabass, other	Yes	Yes
Seabream, gilthead	Yes	Yes
Seabream, other	Yes	Yes
Seaweed and other algae	Yes	Yes
Shrimp Crangon spp	No	No
Shrimp, coldwater	No	No

Shrimp, deep-water rose	No	No
Shrimp, miscellaneous	Yes	Yes
Shrimp, warmwater	Yes	No
Smelt	No	No
Sole, common	Yes	Yes
Sole, other	Yes	Yes
Sprat (=Brisling)	No	No
Squid	No	No
Squillid	No	No
Surimi	No	No
Swordfish	No	No
Tilapia	Yes	No
Toothfish	No	No
Trout	Yes	Yes
Tuna, albacore	No	No
Tuna, bigeye	No	No
Tuna, bluefin	Yes	Yes
Tuna, miscellaneous	No	No
Tuna, skipjack	No	No
Tuna, yellowfin	No	No
Turbot	Yes	Yes
Weever	No	No
Whiting	No	No

9.3 Appendix 3: The salmonid sector

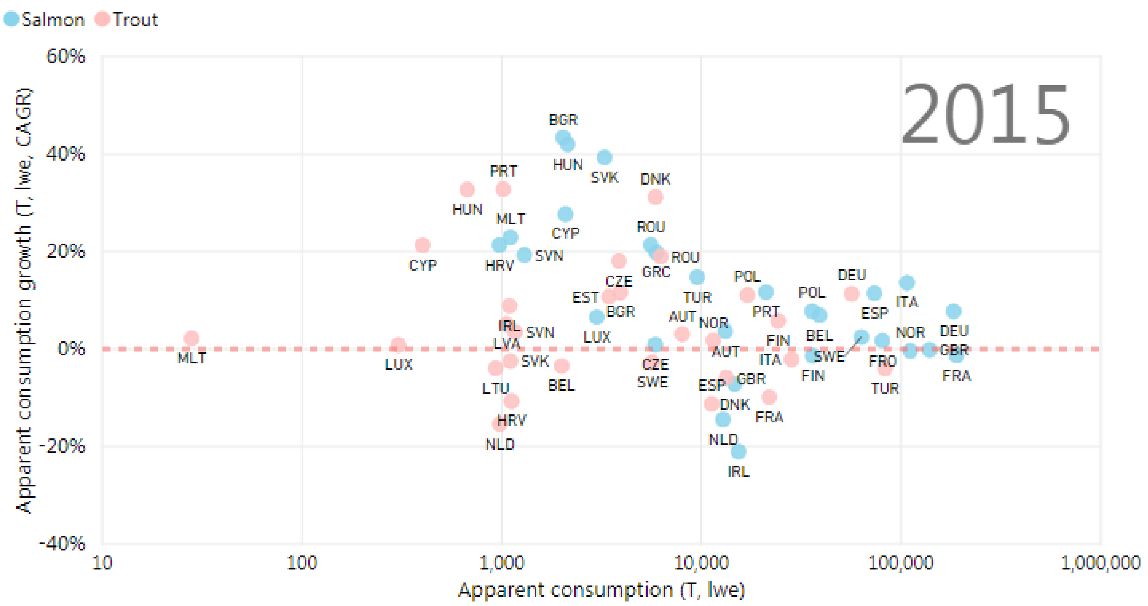
The following section presents a more detailed analysis of the salmonid sector in the EU covering the commercial species Salmon and Trout, disaggregated by member state and main competitors. The analysis also provides contextual background to the following chapters in this thesis. Additional results for other species can be found in Appendix 4: Commercial species profiles.

Among the selected commercial species, Salmon was the one with largest market size by volume and value with France, Germany and the UK being the member states with largest consumption by volume (Figure 9-1 and Figure 9-2). EU production, however, was limited to only the UK and Ireland (Figure 9-3) both of which were net exporters while the vast majority of the market was supplied by imports from Norway. Overall self-sufficiency of the region for this species remained low at around 20%. On the other hand, as one of the most important commecial species in EU aquaculture, trout production was spread more evenly across member states compared to salmon. Germany was the largest market for trout, however with very low self-sufficiecy level (Figure 9-4). A decline in the growth rate of trout consumptuon can be observed in the main markets of trout between 2015 and 2017 (Figure 9-2). Italy, Denmark and France were the largest producer states, all being net exporters of Trout (self-sufficiency rate > 100%). Consumption in the region was largely met by local production, as evidenced from low extra-EU trade in this species. Exports to third countries were less than 20% of the total volume traded in 2017. Specialisation in the export of trout (among other commercial seafood species) was observed for Finland, Austria, Turkey, Estonia, Bulgaria, Norway, Italy, Poland and Denmark, however with negative growth rate (i.e. losing specialisation), while in the case of the UK and Sweden there was positive development in the RCA growth rate. Norway, Sweden, Finland, Lithuania, Poland, Denmark, Czech Republic and the UK all showed specialisation in the export of salmon (Figure 9-5).



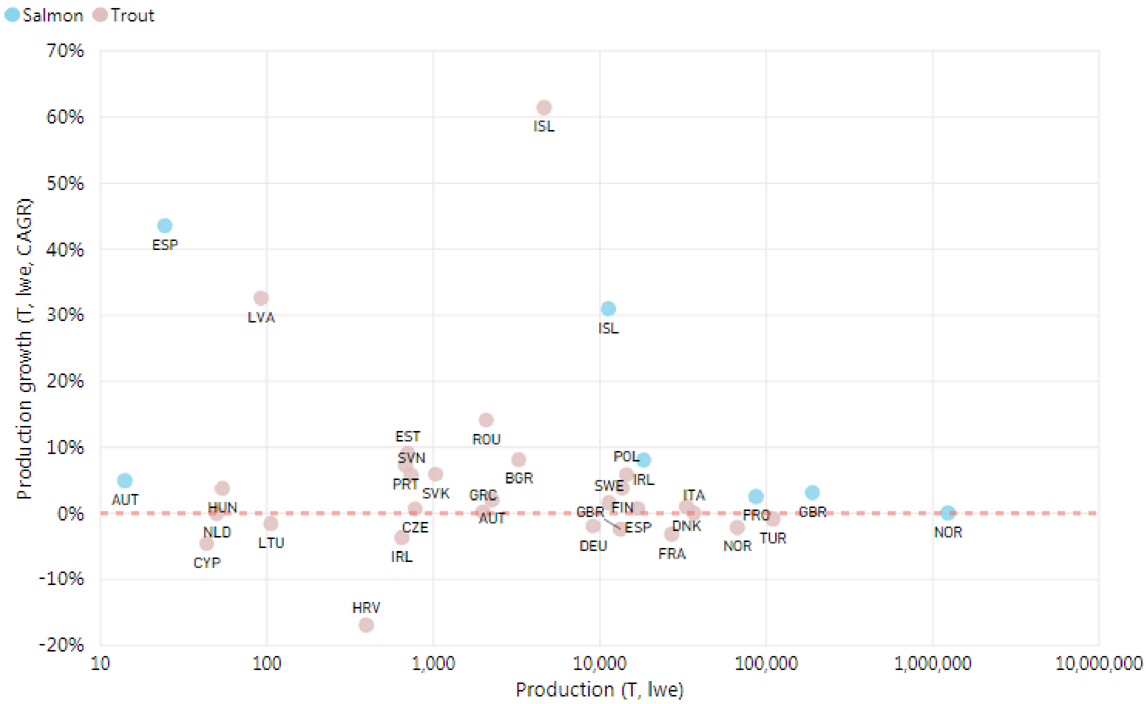
Horizontal axis is on a log-scale. CAGR – compound annual growth rate, based on three-year interval. Data source: FAO (2019), EUROSTAT (2019), UN Comtrade (2019)

Figure 9-1. Market size (volume) of Salmon and Trout by member state and main competitors, 2017



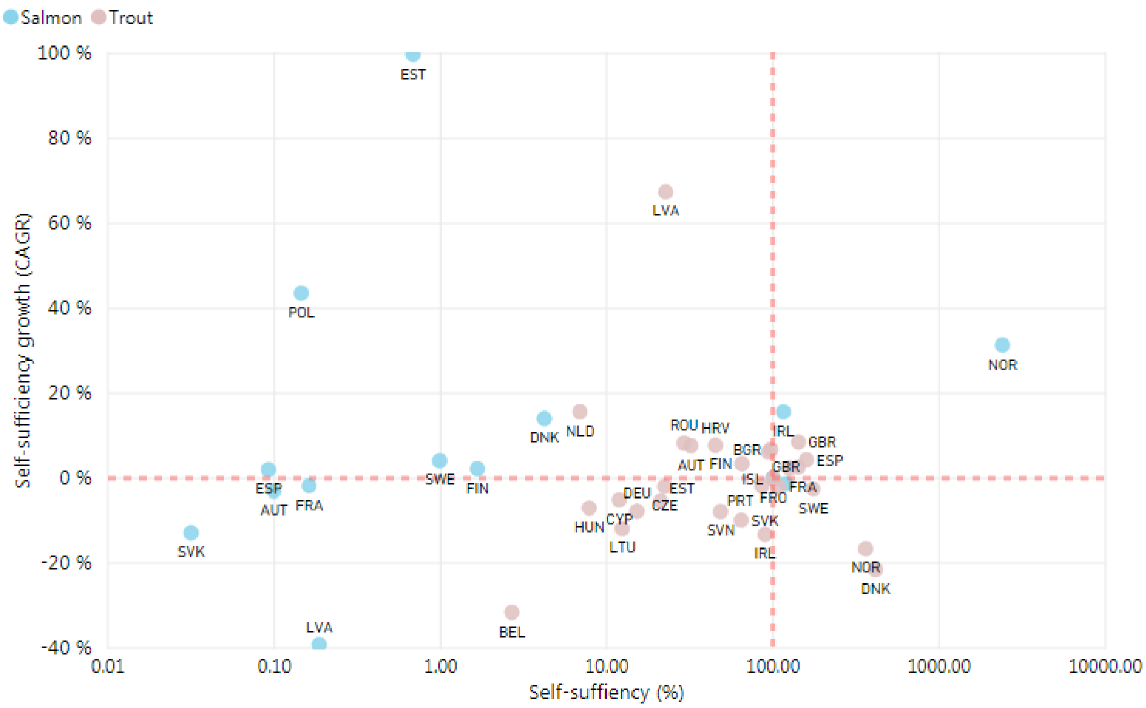
Horizontal axis is on a log-scale. CAGR – compound annual growth rate, based on three-year interval. Data source: FAO (2019), EUROSTAT (2019), UN Comtrade (2019)

Figure 9-2. Market size (volume) of Salmon and Trout by member state and main competitors, 2015



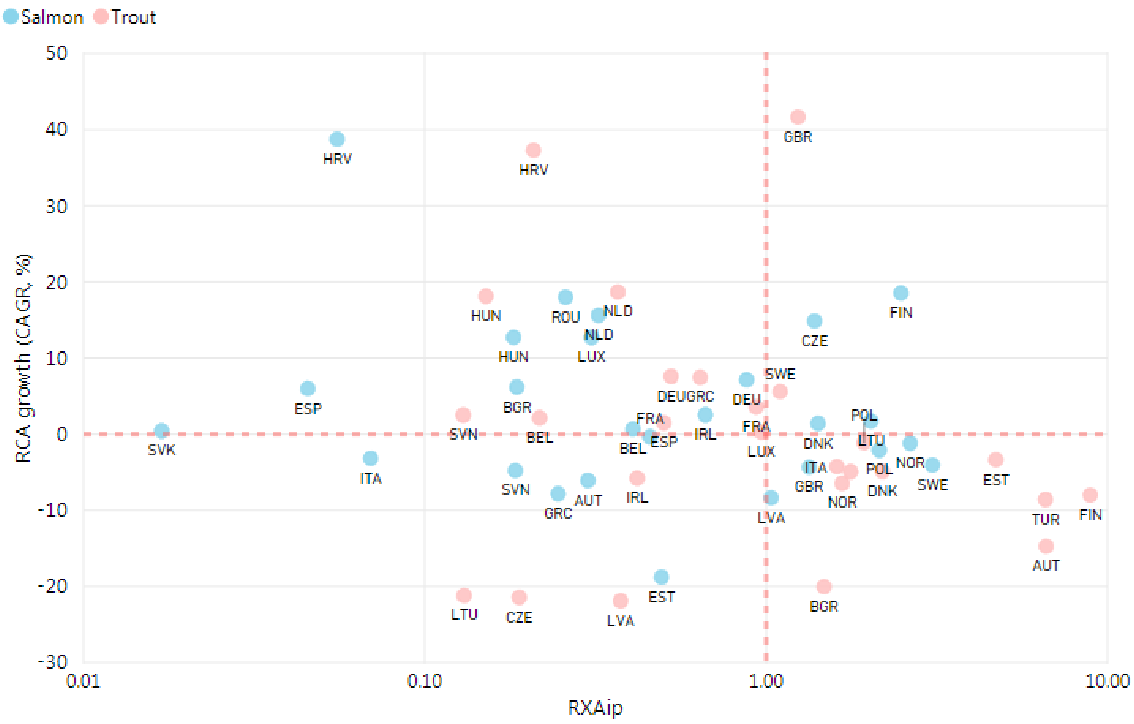
Horizontal axis is on a log-scale. CAGR – compound annual growth rate, based on three-year interval. Data source: FAO (2019)

Figure 9-3. Production of Salmon and Trout by EU28 member state and main competitors, 2017



Only for countries where domestic production was reported. CAGR – compound annual growth rate, based on three-year interval. Horizontal axis is on a log-scale. Data source: FAO (2019), EUROSTAT (2019), UN Comtrade (2019)

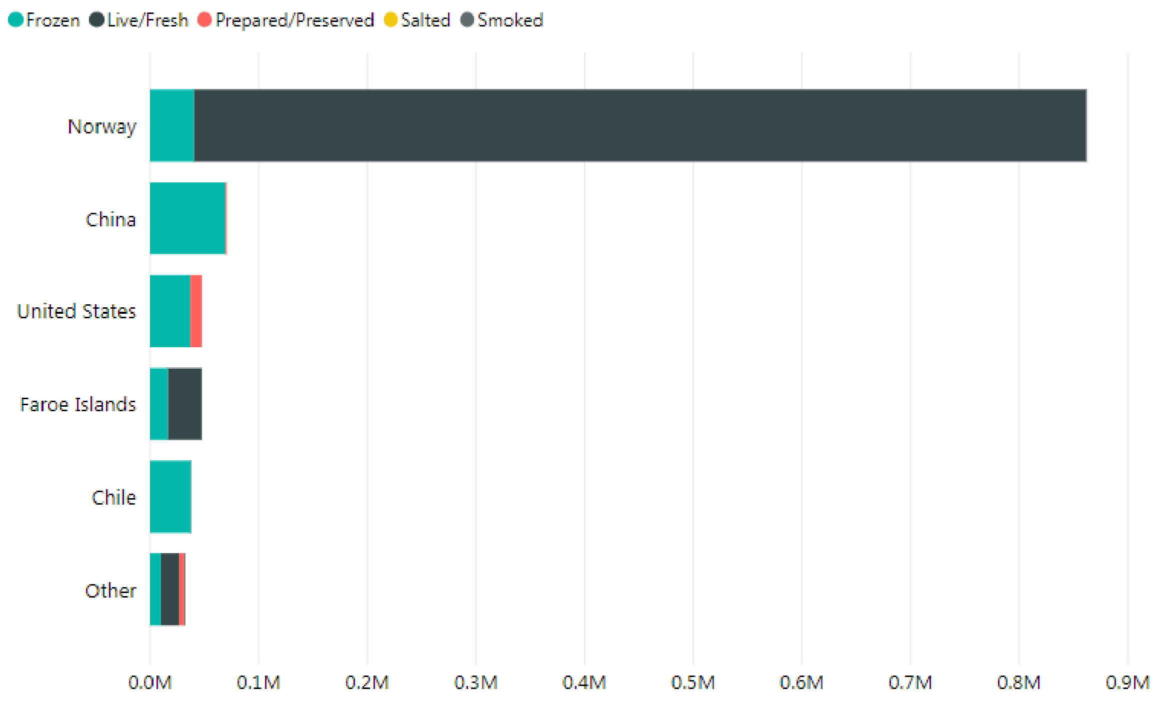
Figure 9-4. Self-sufficiency of Salmon and Trout by member state and main competitors, 2017



Horizontal axis is on a log-scale. CAGR – compound annual growth rate, based on three-year interval. Data source: EUROSTAT (2019), UN Comtrade (2019)

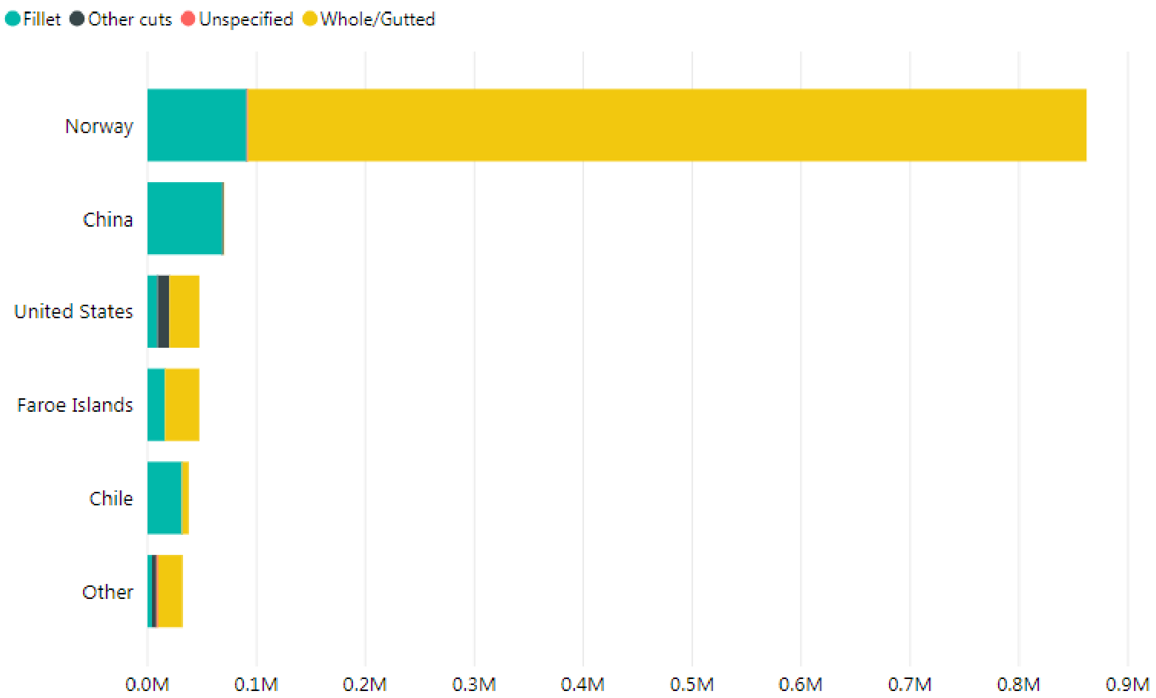
Figure 9-5. Revealed export advantage (RXA) for Salmon and Trout by EU28 member state and main competitors, 2017

Salmon, as indicated previously, was by far the most significant import commodity among the selected commercial species on the EU28 market. The vast majority of imports in 2017 came from Norway (Figure 9-6) in the form of fresh whole/gutted salmon (Figure 9-6 and Figure 9-7).



Data source: EUROSTAT (2019)

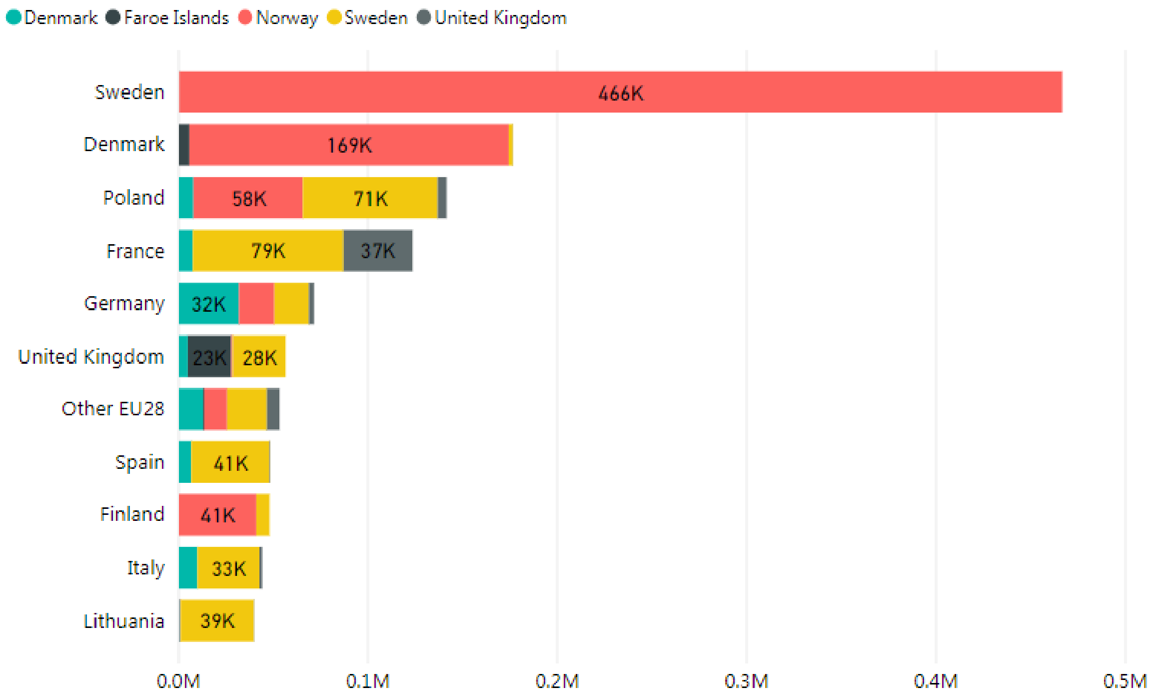
Figure 9-6. Imports of salmon from third countries into the EU28 by type of preservation in 2017, volume (T, lwe)



Data source: EUROSTAT (2019)

Figure 9-7. Imports of salmon from third countries into the EU28 by type of presentation in 2017, volume (T, lwe)

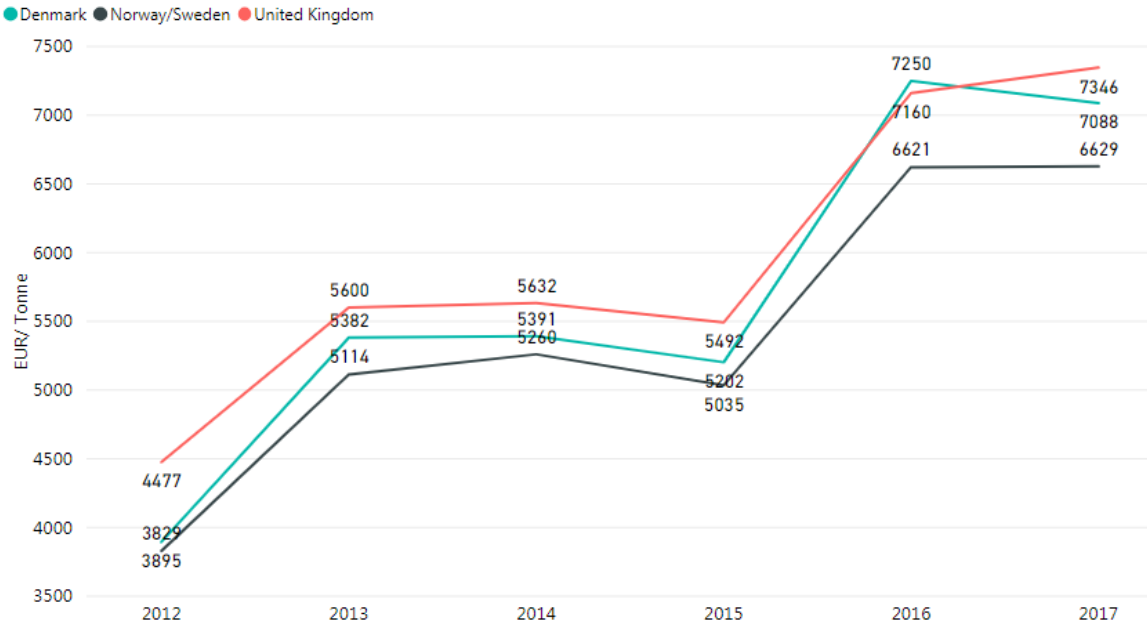
According to EUROSTAT (2019), the main importer member states in 2017 were Sweden, Denmark and Poland (Figure 9-8). However, in reality Sweden and Denmark are primarily transit states through which Norwegian salmon reaches its final destinations within the EU, as the figure indicates for the countries where Sweden and Denmark are shown as main sources of salmon. Poland was a main processing centre for salmon in the EU.



Data source: EUROSTAT (2019)

Figure 9-8. Imports of whole/gutted fresh salmon by MS (top 10 importers) and by country of origin in 2017, volume (T, lwe)

A comparison of the prices of imported fresh whole gutted salmon on the French market from main sources indicates that the United Kingdom had consistently higher price of around 15-20%, relative to imports from Norway/Sweden (Figure 9-9). The reasons for this are discussed in Chapter 4.

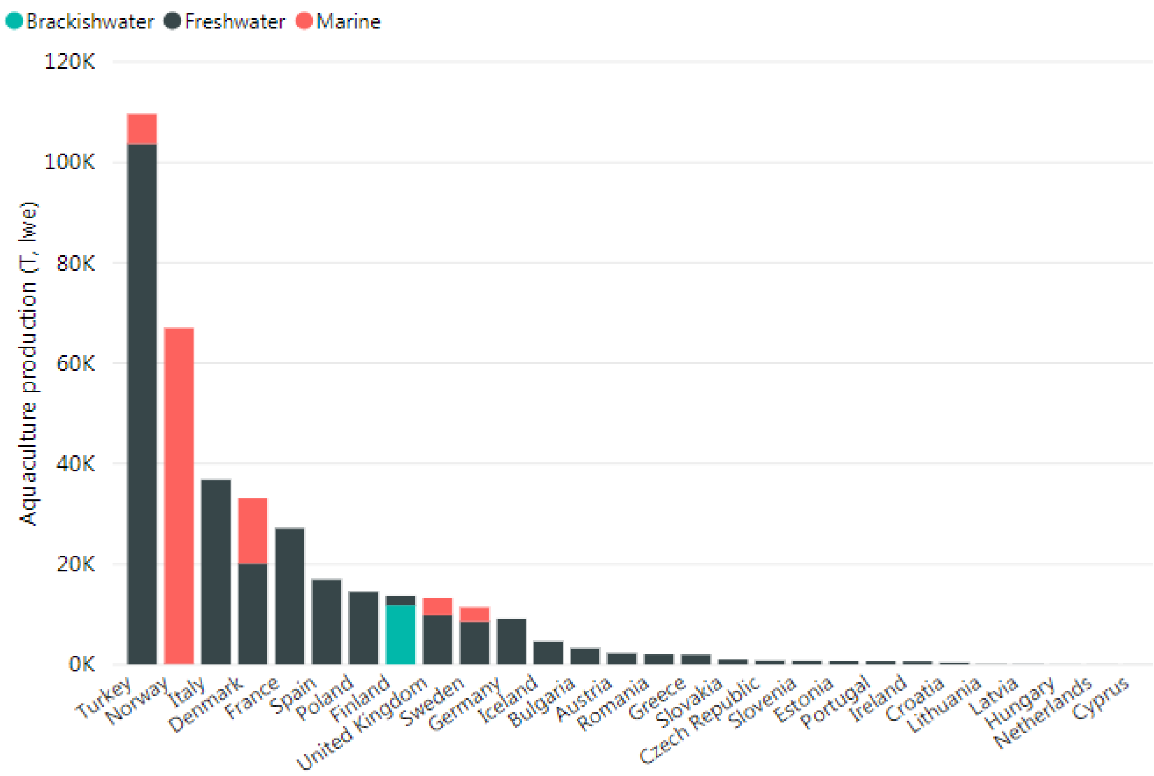


Data source: EUROSTAT (2019)

Figure 9-9. Price of imported fresh whole/gutted salmon into France from main sources, 2012-2017

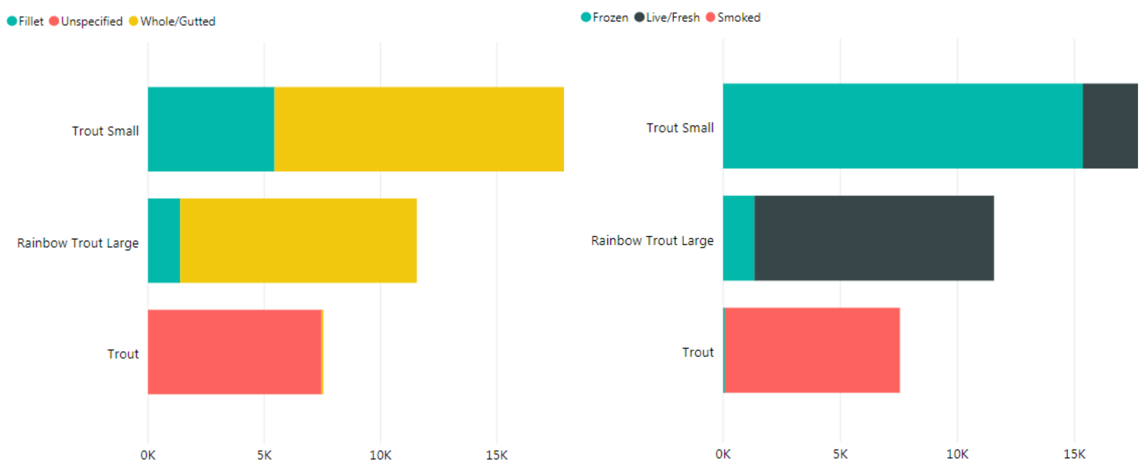
Unlike salmon, trout can be produced in aquatic environments with different levels of salinity (from freshwater to full-strength seawater), Figure 9-10. Because of the different farming technologies used in those environments, fish reared in marine water are typically grown to a larger size (harvest size 4-5 kg, similar to salmon), whereas in freshwater – usually of size <0.5 kg (plate-size fish). The size difference determines the attributes of the final products.

Around half of the 37,000 tonnes (lwe) of trout imported from third countries into the EU in 2017 consisted of small (plate-size) trout, dominated by whole/gutted frozen products (Figure 9-11). On the other hand, in the case of large rainbow trout, imports were composed of whole fresh products. The remaining volume of unspecified size class consisted of smoked trout.



Data source: FAO (2019)

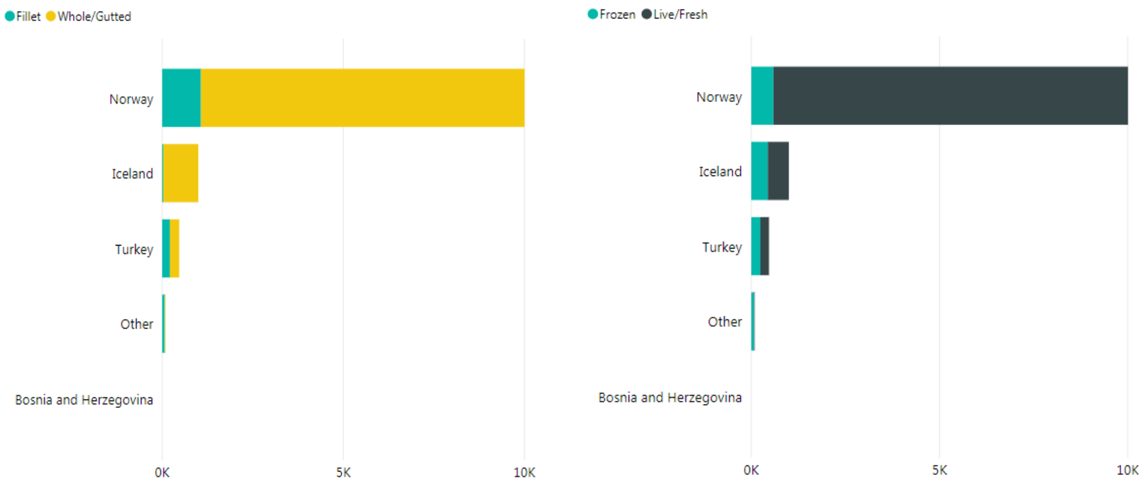
Figure 9-10. Rainbow trout production by environment, 2017



Data source: EUROSTAT (2019)

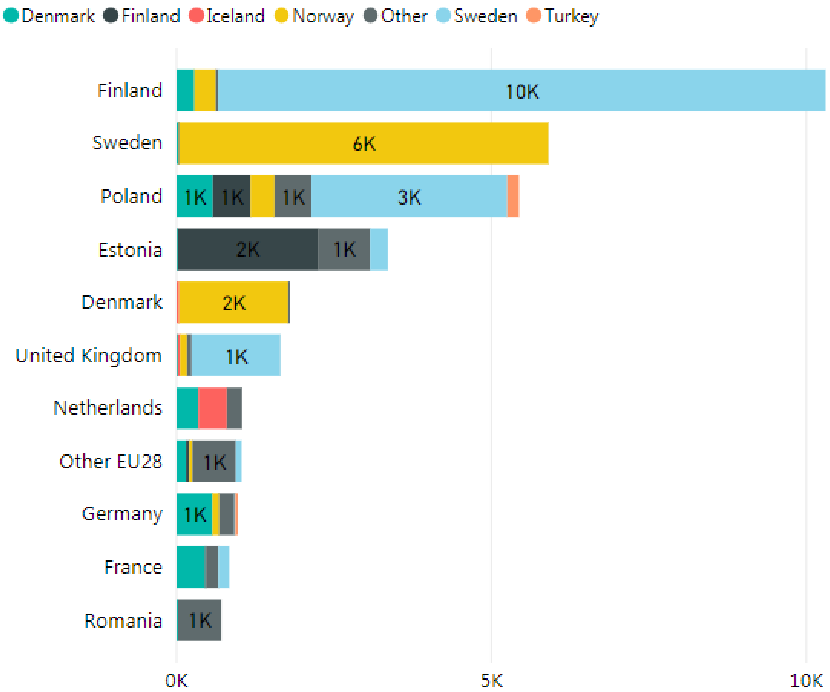
Figure 9-11. Imports of trout from third countries into the EU28 by size and type of presentation (L) and preservation (R) in 2017, volume (T, lwe).

The main third countries exporting large trout to the EU were Norway, Iceland and Turkey, with Norway by far dominating exports in this category (Figure 9-12). The main importing member states of were Finland, Sweden and Poland, Estonia and Denmark with considerable trade between these states (Figure 9-13), particularly from Norway to Sweden and from Sweden to other MS.



Data source: EUROSTAT (2019)

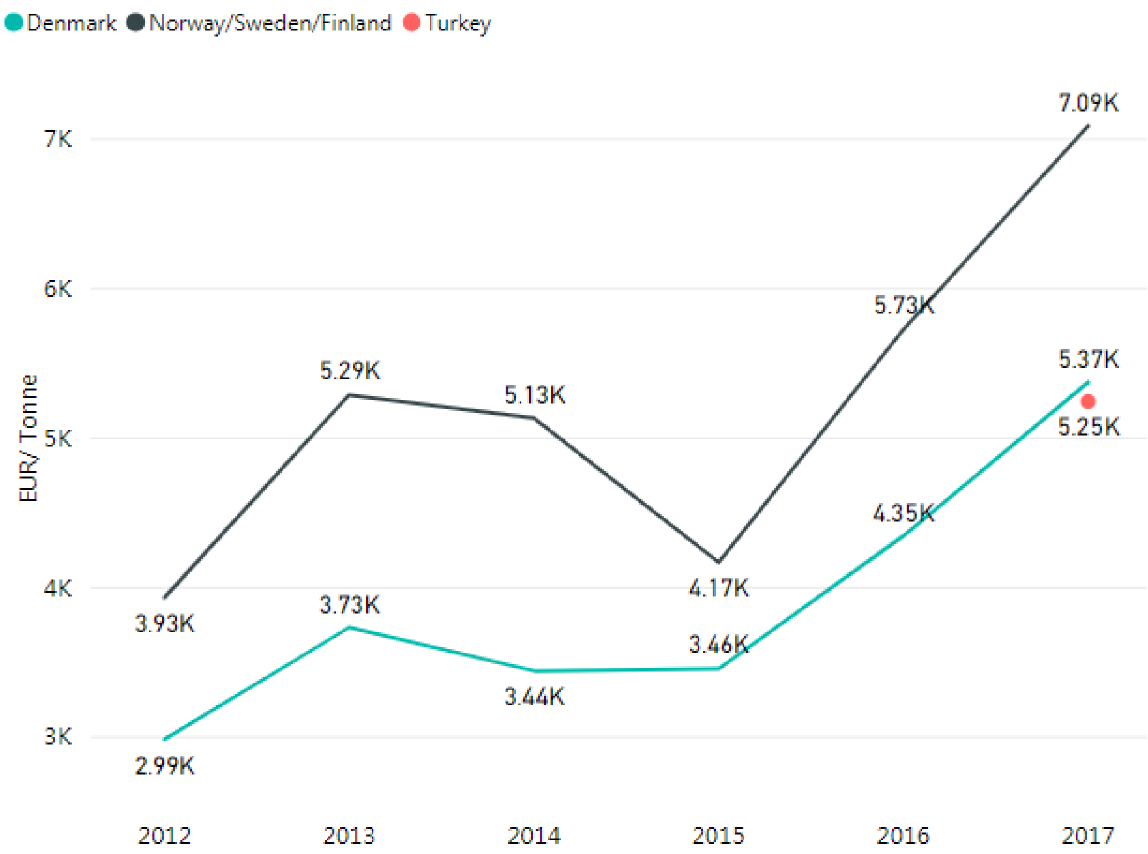
Figure 9-12. Imports of large rainbow trout from third countries into the EU28 by type of presentation (L) and preservation (R) in 2017, volume (T, lwe)



Data source: EUROSTAT (2019)

Figure 9-13. Imports of whole/gutted fresh large rainbow trout by top 10 member states and country of origin in 2017, volume (T, lwe)

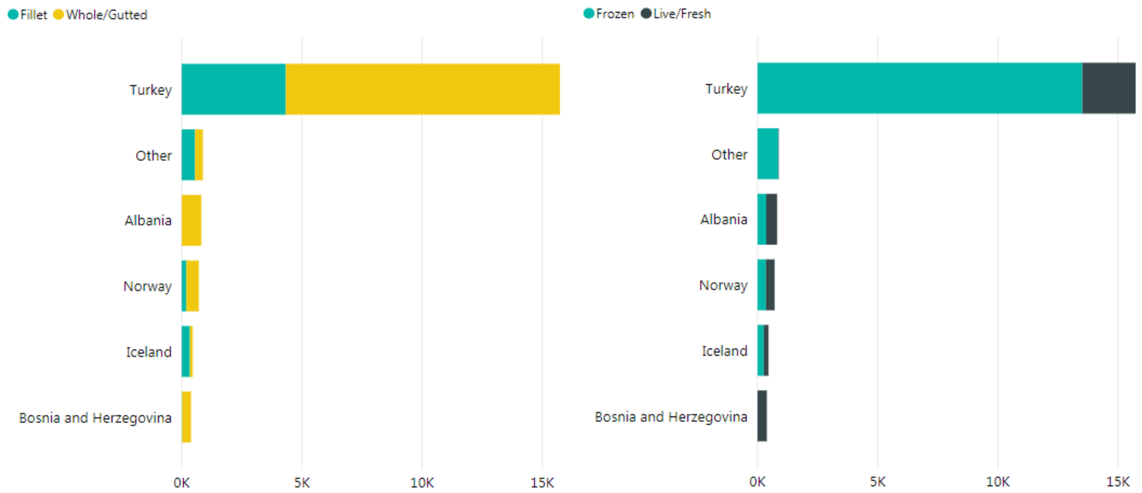
A price comparison of large rainbow trout imports into Poland, which had the most diverse range of import sources, revealed that Danish trout had a consistently lower price than imports from Norway, Sweden, Finland (grouped together because of the likely single origin Norway). Import from Turkey were recorded in only one year in the period examined and were comparable to the price of imports from Denmark (Figure 9-14).



Data source: EUROSTAT (2019)

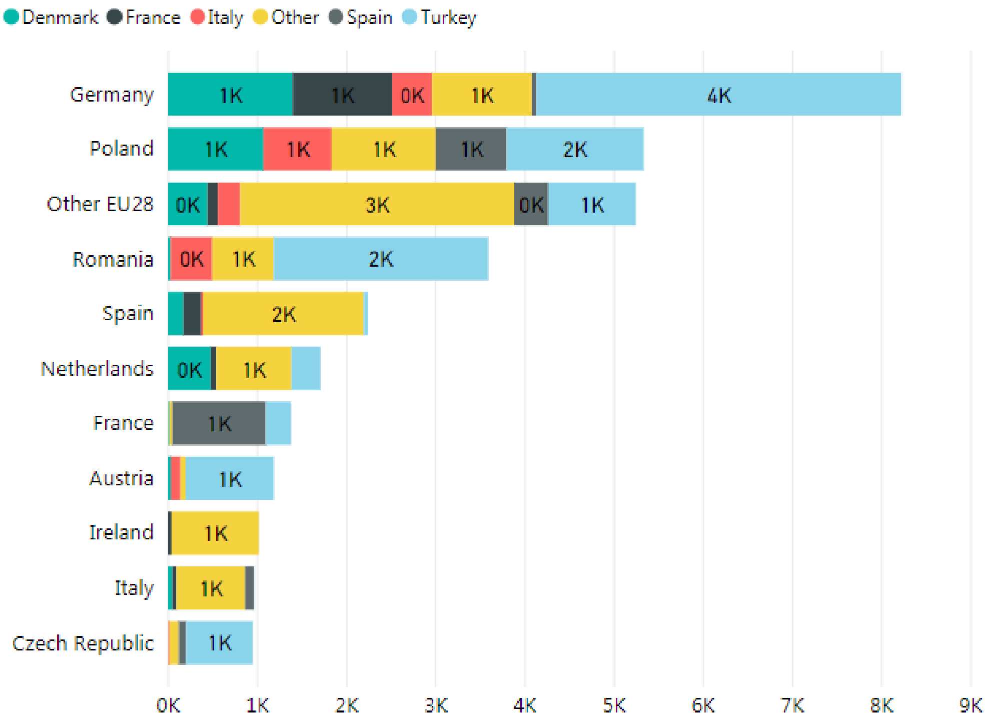
Figure 9-14. Price of imported fresh whole/gutted large rainbow trout into Poland from main sources, 2012-2017

In the case of small (plate-size) trout, Turkey by far dominated the third country imports into the EU (Figure 9-15). Germany was the main importer of Turkish trout and the main EU market on which plate-size trout from other EU producer countries was consumed, particularly from Denmark, France and Italy (Figure 9-16). A price comparison reveals that on the German market, Turkish trout had considerably lower and more consistent price than other main exporter states (Figure 9-17). Price of Turkish trout was even lower on the Polish market, but still higher than Italian imports in the period 2013-2017 (Figure 9-18).



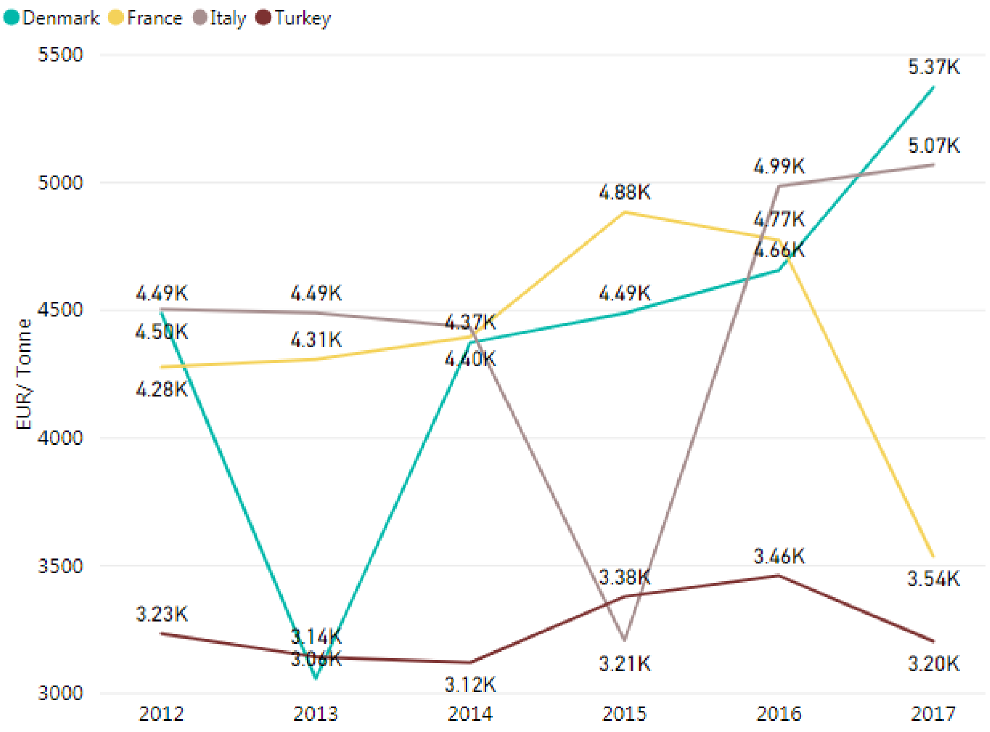
Data source: EUROSTAT (2019)

Figure 9-15. Imports of small rainbow trout from third countries into the EU28 by type of presentation (L) and preservation (R) in 2017, volume (T, lwe)



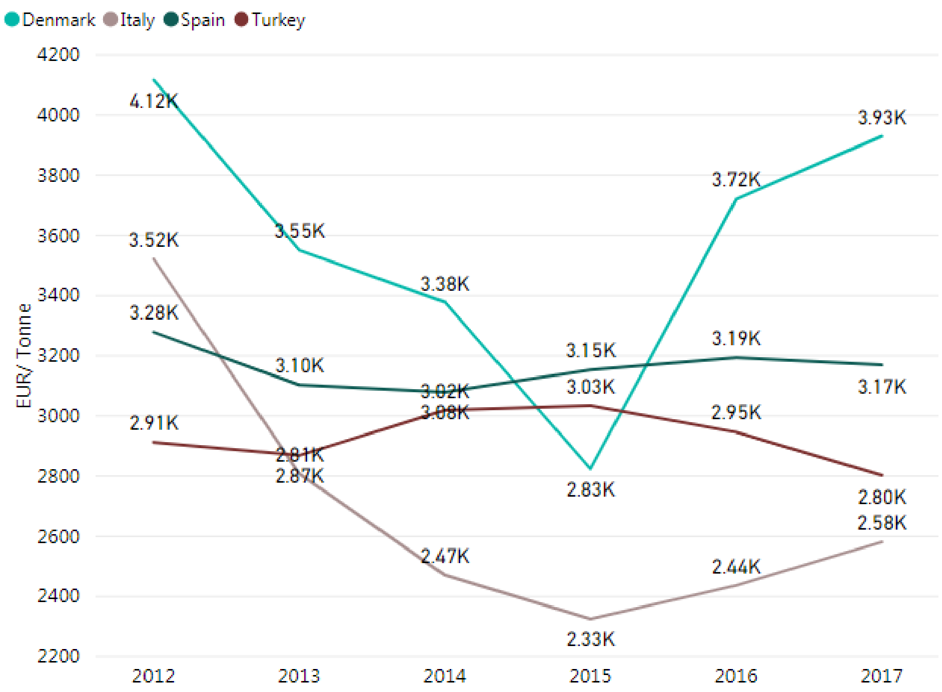
Data source: EUROSTAT (2019)

Figure 9-16. Imports of whole/gutted fresh or frozen small rainbow trout by MS (top 10) and by country of origin in 2017, volume (T, lwe)



Data source: EUROSTAT (2019)

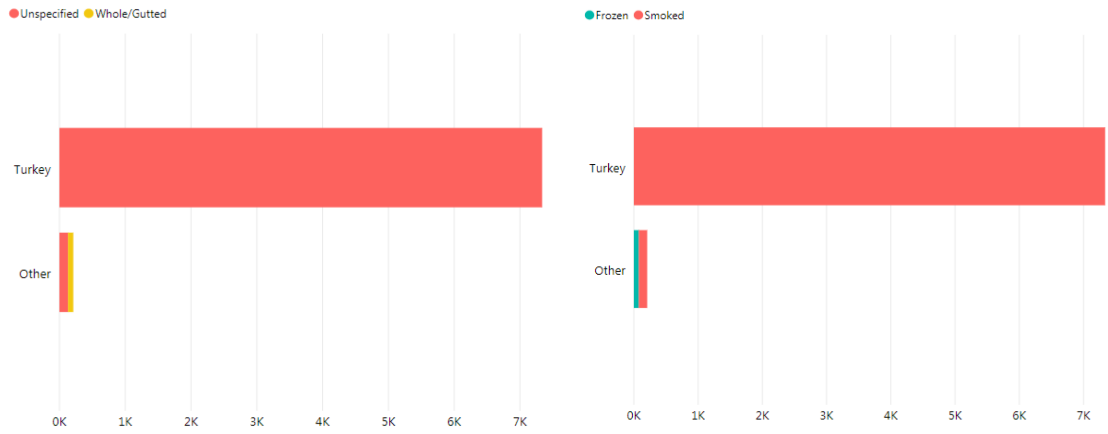
Figure 9-17. Price of imported fresh or frozen whole/gutted small rainbow trout into Germany from main sources, 2012-2017



Data source: EUROSTAT (2019)

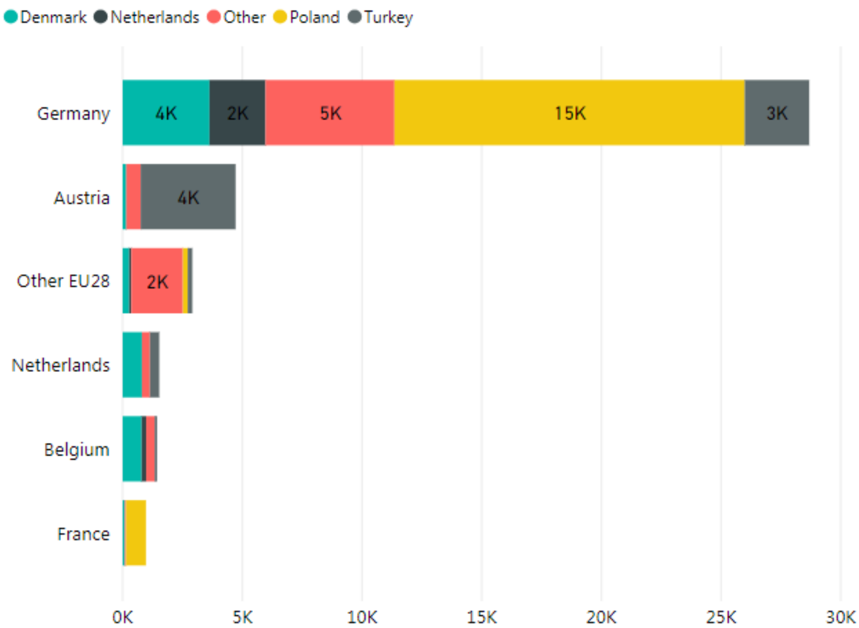
Figure 9-18. Price of imported fresh or frozen whole/gutted small rainbow trout into Poland from main sources, 2012-2017

More than 7,000 tonnes (lwe) of smoked trout from Turkey were imported into the EU in 2017 (Figure 9-19), mainly on the German and Austrian markets (Figure 9-20). On the German market, smoked Turkish trout had a lower price than imports from Poland and Denmark, but a higher price than Netherlands (Figure 9-21).



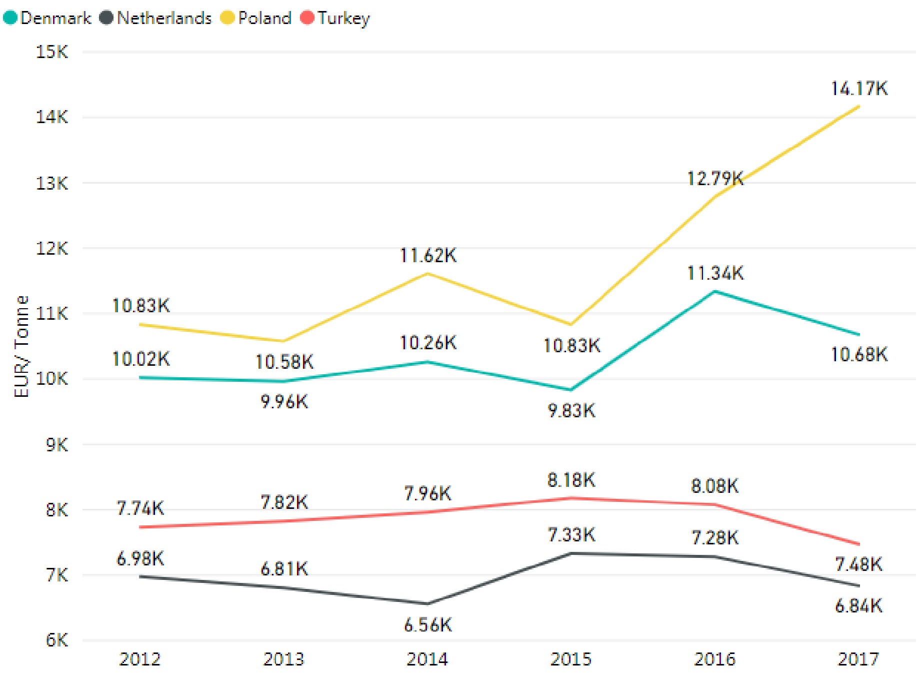
Data source: EUROSTAT (2019)

Figure 9-19. Imports of trout from third countries into the EU28 by type of presentation (L) and preservation (R) in 2017, volume (T, lwe)



Data source: EUROSTAT (2019)

Figure 9-20. Imports of whole/gutted fresh or frozen small rainbow trout by MS (top 10) and by country of origin in 2017, volume (T, lwe)



Data source: EUROSTAT (2019)

Figure 9-21. Price of imported smoked rainbow trout into Germany from main sources, 2012-2017

9.4 Appendix 4: Commercial species profiles

Table 9-1. Key market and production indicators for Carp in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Poland	22761	-0.7%	19629	1.0%	0.35	-9	86.2	-2%
Hungary	14665	-5.1%	17640	1.2%	52.63	15	120.3	5%
Romania	13634	8.3%	10436	3.5%	0.46	75	76.5	-5%
Czech Republic	13085	-2.3%	22555	0.2%	86.96	-3	172.4	4%
Germany	8727	2.3%	4710	-3.5%	0.04	-2	54.0	-6%
Bulgaria	5143	7.5%	7149	15.7%	31.79	19	139.0	9%
United Kingdom	4745	61.3%			0.03	47		
France	4278	-2.9%	4003	-1.0%	0.14	-13	93.6	1%
Slovakia	3603	14.5%	2109	1.3%	0.02	25	58.5	-7%
Lithuania	2997	1.8%	3200	-1.0%	2.11	-17	106.8	-5%
Croatia	1758	-6.9%	2955	-2.2%	7.69	-7	168.1	1%
Italy	1617	44.3%	542	42.9%	0.24	14	33.5	11%
Austria	962	1.8%	666	1.3%	1.27	56	69.2	1%
Latvia	816	14.7%	622	4.9%	0.66	27	76.2	-8%
Netherlands	461	150.9%			0.04	2		
Greece	204	-4.0%	209	-2.7%	0.02	12	102.7	1%
Slovenia	195	0.1%	183	-2.2%	0.18	-26	94.0	-2%
Belgium	139	69.1%	11	0.0%	0.24	-8	7.9	-41%
Sweden	138	35.0%			0.01	31		
Ireland	52	12.9%				-100		
Luxembourg	22	-339.9%			3.29	31		
Cyprus	10					-100		
Estonia	9	-43.1%	6	-31.7%	0.01	-25	68.2	-10%
Finland	1	71.0%				-100		
Portugal	1					-100		
Spain	0	-68.1%	2	53.8%	0.01	51	537.5	196%

Data source: FAOSTAT 2019, EUROSTAT, 2019

9.4.1 Catfish

Table 9-2. Key market and production indicators for Catfish in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
United Kingdom	31655	1.5%			0.67	37		
Germany	20536	-12.1%	1257	14.3%	1.42	-1	6.1	20%
Netherlands	18551	-20.6%	2900	19.3%	3.34	3	15.6	26%
Italy	15642	-19.5%	300	6.4%	0.21	-23	1.9	82%
Poland	14818	-8.3%	226	-17.4%	0.41	-5	1.5	-20%
Spain	13919	-42.5%			0.33	2		
France	9608	-3.4%	219	-7.4%	0.16	-4	2.3	5%
Hungary	8646	2.8%	3576	9.5%	1.95	11	41.4	10%
Belgium	7005	-8.5%			4.67	2		
Greece	6986	-13.6%	18	0.0%	0.05	-21	0.3	16%
Portugal	6754	-1.0%			0.46	-14		
Romania	6430	-19.1%	252	-6.6%	0.69	-43	3.9	1%
Austria	3651	-1.0%	445	11.1%	0.74	-3	12.2	9%
Bulgaria	2958	-11.8%	1137	55.8%	0.33	-35	38.4	75%
Sweden	2551	-11.0%			0.02	-7		
Cyprus	2315	-11.2%			0.31	-100		
Denmark	1241	-13.0%			0.27	-10		
Croatia	1223	-7.7%	71	-0.7%	0.58	33	5.8	5%
Czech Republic	982	-13.5%	213	6.3%	1.88	-15	21.7	26%
Lithuania	910	-21.4%	173	57.9%	0.26	-11	19.0	80%
Estonia	722	-3.7%			1.57	41		
Slovenia	718	-26.1%	7	-2.6%	44.22	48	1.0	42%
Malta	590	3.2%				-100		
Finland	457	15.5%				-100		
Latvia	413	-34.5%			0.58	-8		
Slovakia	358	-34.0%	75	3.4%	6.30	15	20.8	69%
Ireland	357	-152.3%			0.00	-90		
Luxembourg	189	38.7%			0.15	-46		

Data source: FAOSTAT 2019, EUROSTAT, 2019

9.4.2 Seabass and seabream

Table 9-3. Key market and production indicators for Seabass in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Italy	30651	3.7%	7037	-0.1%	1.11	17	23.0	2%
Spain	21446	0.3%	18258	3.8%	0.91	3	85.1	1%
France	10375	2.0%	4913	-7.6%	0.56	-12	47.4	-11%
United Kingdom	8060	4.7%	438	-16.6%	0.08	-9	5.4	-33%
Portugal	7283	12.9%	998	2.1%	0.15	-2	13.7	-15%
Greece	7172	22.9%	44526	4.3%	24.74	0	620.8	-9%
Germany	1827	5.4%	0		0.25	12	0.0	
Croatia	1501	5.0%	5626	18.0%	10.10	20	374.8	15%
Cyprus	825	2.4%	2255	15.4%	23.51	2	273.4	5%
Bulgaria	765	27.1%			0.46	-35		
Belgium	683	-4.1%	22	-32.3%	0.25	21	3.2	-45%
Ireland	492	1.7%			0.00	-60		
Romania	442	23.6%			0.09	70		
Slovenia	440	4.5%	84	8.8%	1.81	11	19.1	2%
Austria	228	1.4%			0.22	-37		
Slovakia	201	56.5%			0.00	-100		
Luxembourg	111	40.9%			0.83	8		
Poland	92	-38.3%			0.00	-100		
Czech Republic	82	51.7%			0.02	111		
Malta	74	-16.1%	59	-14.0%	0.00	-100	80.5	-19%
Sweden	68	0.4%			0.00	8		
Hungary	45	19.6%			0.00	-32		
Lithuania	41	29.7%			0.01	11		
Denmark	29	-22.4%			0.01	-10		
Finland	6	14.5%				-100		
Estonia	4	-14.6%			0.05	32		
Latvia	0	-72.0%			0.04	27		

Data source: FAOSTAT 2019, EUROSTAT, 2019

Table 9-4. Key market and production indicators for Seabream in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Italy	34975	3.6%	8656	4.4%	1.55	27	24.8	2%
Spain	22197	5.3%	18232	0.9%	0.51	-8	82.1	-4%
Portugal	14011	11.1%	1461	5.4%	0.23	18	10.4	-18%
France	12363	3.6%	2362	3.3%	0.23	-3	19.1	-6%
Greece	8024	-9.6%	56331	1.0%	29.73	2	702.0	14%
Germany	5228	11.1%			0.28	12		
United Kingdom	3037	1.0%	0		0.02	-17	0.0	
Netherlands	2389	5.4%			0.41	20		
Croatia	1610	4.9%	4992	17.3%	9.10	24	310.0	5%
Cyprus	1516	19.0%	4953	9.3%	46.60	0	326.8	0%
Romania	1052	34.4%			0.21	79		
Belgium	531	4.5%			0.16	120		
Bulgaria	486	11.8%			0.24	-41		
Slovenia	381	3.4%	20	12.7%	0.71	-20	5.3	-3%
Austria	340	10.7%			1.74	-12		
Luxembourg	283	38.0%			0.56	12		
Malta	254	-41.2%	2460	-1.2%	0.00	-100	967.8	65%
Poland	197	-6.6%			0.03	229		
Lithuania	188	44.0%			0.01	4		
Sweden	122	10.8%			0.00	-36		
Denmark	118	16.8%			0.00	-15		
Czech Republic	62	20.8%			0.05	152		
Hungary	35	18.9%			0.00	-43		
Estonia	23	78.8%			0.00	149		
Latvia	23	-476.1%			0.04	8		
Slovakia	12	-20.6%				-100		
Finland	5	-12.1%				-100		

Data source: FAOSTAT 2019, EUROSTAT, 2019

9.4.3 Clam

Table 9-5. Key market and production indicators for Clam in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Italy	70464	8.0%	50138	3.2%	7.27	-1	71.2	-9%
Spain	68938	-2.6%	11280	-0.6%	0.66	5	16.4	1%
Portugal	20380	-22.7%	11037	10.3%	3.51	7	54.2	45%
Denmark	8129	10.3%	8866	105.8%	0.12	42	109.1	2%
France	4651	-3.4%	8803	3.6%	1.44	12	189.3	6%
United Kingdom	4139	-19.1%	6875	12.7%	1.23	-14	166.1	6%
Germany	1174	35.4%	9		0.04	-8	0.8	
Belgium	1060	-2.7%			0.13	12		
Romania	291	22.4%						
Luxembourg	227	7.8%			0.16	55		
Croatia	201	18.0%	177	29.8%	0.21		88.2	-9%
Poland	197	-159.6%			0.00	7		
Hungary	189	49.5%			0.02	-33		
Czech Republic	185	150.4%			0.03	60		
Austria	175	10.1%			0.04	-2		
Sweden	157	-40.2%	5	10.8%	0.00	-15	3.2	186%
Malta	103	-29.0%						
Slovenia	66	18.3%	5	20.1%	0.44	48	7.6	-29%
Slovakia	29	126.2%						
Cyprus	22	143.6%						
Finland	21	37.0%						
Latvia	2	-19.0%						
Estonia	0	-11.8%						

Data source: FAOSTAT 2019, EUROSTAT, 2019

9.4.4 *Oyster*

Table 9-6. Key market and production indicators for Oyster in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
France	60567	-6.1%	64959	-4.2%	8.45	2	107.3	1%
Italy	5495	4.8%	145	25.3%	0.27	-16	2.6	-5%
Ireland	3449	-8.2%	10409	6.6%	9.56	4	301.8	11%
Belgium	1895	-6.3%			0.04	-23	0	
Portugal	1457	38.8%	2116	20.9%	0.34	-6	145.2	-11%
Netherlands	1078	-14.8%	3267	5.2%	0.82	-3	303.2	17%
Germany	1047	11.1%	80	0.0%	0.06	5	7.6	-10%
United Kingdom	1039	9.3%	2359	9.1%	0.38	-19	227.1	4%
Bulgaria	816	386.1%						
Sweden	406	35.2%	8	-6.2%	0.00	-24	2.0	-19%
Austria	139	10.2%			0.04	-11		
Luxembourg	114	2.2%			0.96	5		
Cyprus	61	17.3%				-100		
Lithuania	57	58.2%			0.00	-48		
Croatia	52	-25.7%	237	27.7%	0.86	124	456.3	8%
Czech Republic	50	1.5%			0.01	-5		
Latvia	39	8.5%			0.14	6		
Poland	37	-41.0%			0.01	144		
Romania	22	16.6%			0.04	102		
Slovenia	16	7.4%			1.98	120		
Finland	13	37.4%			0.00	-78		
Hungary	9	-11.3%			0.01	6		
Estonia	9	43.8%			0.00	61		
Malta	7	-5.0%				-100		
Slovakia	1	26.0%				-100		
Spain			1300		1.09	74		

Data source: FAOSTAT 2019, EUROSTAT, 2019

9.4.5 *Mussels*

Table 9-7. Key market and production indicators for Mussels in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Spain	180741	0.7%	241924	3.5%	1.53	4	133.9	2%
France	143665	0.1%	57339	-6.8%	0.52	5	39.9	-3%
Italy	126890	2.8%	63700	0.1%	1.34	7	50.2	-3%
Belgium	39308	8.0%			0.40	3	0	
Netherlands	22571	17.1%	53000	5.8%	3.35	-1	234.8	-15%
United Kingdom	18031	-12.7%	16865	-13.3%	0.19	-23	93.5	7%
Portugal	12160	13.6%	1218	23.6%	0.57	8	10.0	-16%
Greece	11503	16.4%	19240	2.9%	0.88	2	167.3	-10%
Germany	10928	-20.5%	16856	19.4%	1.06	14	154.2	85%
Denmark	9752	12.4%	43058	1.5%	0.85	0	441.5	-11%
Sweden	4920	1.5%	2014	6.1%	0.03	-11	40.9	2%
Ireland	3942	1.3%	17110	-3.7%	2.14	-6	434.1	10%
Bulgaria	3204	3.9%	3303	30.2%	0.60	40	103.1	5%
Croatia	2114	10.8%	949	15.3%	0.09	26	44.9	-4%
Austria	1801	1.1%			0.17	10		
Poland	1411	12.3%			0.00	-22		
Romania	1304	28.3%	142	66.8%	0.04	6	10.9	37%
Slovenia	1250	15.6%	641	15.7%	0.61	10	51.3	-1%
Cyprus	1067	5.0%			0.06	-100		
Luxembourg	725	-0.5%			0.42	8		
Hungary	679	8.0%			0.01	-64		
Malta	606	-11.7%				-100		
Finland	571	4.0%			0.00	-37		
Czech Republic	510	10.9%			0.07	0		
Latvia	412	21.1%			0.14	9		
Estonia	369	22.2%			0.04	-18		
Lithuania	353	-4.2%			0.02	-10		
Slovakia	77	4.1%			0.04	52		

Data source: FAOSTAT 2019, EUROSTAT, 2019

9.4.6 Tilapia

Table 9-8. Key market and production indicators for Tilapia in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Spain	13503	-7.5%	1		0.08	-28	0.0	-56%
Poland	11834	5.3%	100	-12.9%	0.65	-14	0.9	-53%
Germany	6646	-1.0%	112	25.5%	0.61	-8	1.7	0%
United Kingdom	5544	-5.0%	1	-60.0%	0.28	-28	0.0	-79%
France	5217	-5.3%			0.13	-10		
Italy	4550	0.2%	1	0.0%	0.04	-33	0.0	-6%
Belgium	1117	-8.5%			2.66	-8		
Czech Republic	955	-14.2%			1.98	19		
Austria	740	-2.9%			0.46	-12		
Denmark	654	-8.7%			0.27	-9		
Hungary	644	32.7%			0.31	-29		
Sweden	584	-12.1%			0.03	-16		
Bulgaria	562	23.0%				-100		
Portugal	470	166.9%			0.25	-8		
Slovakia	429	3.8%			0.22	118		
Lithuania	372	-12.1%			0.43	-4		
Ireland	368	13.9%			0.00	-100		
Estonia	210	13.7%			0.07	-4		
Romania	168	8.0%			0.00	-100		
Finland	164	13.2%			0.00	-45		
Latvia	159	-21.5%			0.73	1		
Greece	93	-20.9%			0.01	-13		
Luxembourg	86	-35.1%			0.08	-42		
Cyprus	65	4.0%				-100		
Slovenia	51	67.3%			7.38	94		

Data source: FAOSTAT 2019, EUROSTAT, 2019

9.4.7 Turbot

Table 9-9. Key market and production indicators for Turbot in the EU by country, 2017

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Spain	7060	11.8%	8830	2.5%	2.93	0	125.1	-7%
Italy	2497	-2.6%	62	-36.5%	0.35	-4	2.5	-55%
France	2075	-0.9%	1031	5.2%	0.93	0	49.7	0%
Portugal	992	-14.7%	2453	-11.2%	4.66	-5	247.3	3%
Netherlands	840	-4.6%	2236	3.1%	1.92	3	266.3	15%
Germany	792	2.9%	312	6.1%	0.34	8	39.4	2%
United Kingdom	750	-1.1%	920	4.0%	0.37	18	122.7	4%
Ireland	722	14.6%	228	2.2%	0.20	3	31.6	-3%
Belgium	446	6.6%	565	6.3%	0.73	25	126.6	2%
Sweden	198	-0.8%	22	-9.4%	0.00	-55	11.1	-17%
Austria	85	3.6%			0.04	0		
Poland	84	12.5%	63	-0.9%	0.00	-54	74.9	14%
Denmark	79	58.1%	742	0.8%	0.51	0	937.6	-34%
Romania	76	-7.5%	43	0.0%	0.03	-36	56.4	-2%
Greece	56	-12.5%	66	1.3%	0.02	-17	117.0	5%
Slovenia	46	14.9%	1	0.0%	0.42	7	2.2	-31%
Croatia	45	-4.6%	25	1.7%	0.71	14	55.4	5%
Luxembourg	43	-2.1%			1.94	440		
Czech Republic	11	26.9%			0.00	-5		
Lithuania	9	-8.0%	7	-11.6%			82.0	9%
Finland	8	-11.2%	0				0.0	
Latvia	6	-33.4%	2	-27.5%	0.01	-23	34.8	-1%
Hungary	2	8.2%			0.03	-14		
Estonia	1		1		0.00		100.0	
Cyprus	1	-16.5%						
Slovakia	1	-235.7%			0.00			

Data source: FAOSTAT 2019, EUROSTAT, 2019