Are there plenty of fish in the sea?

A study on how policy has influenced Norwegian fish exports and EU's domestic aquaculture between 1995-2015.

Melina Läggeberger

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Swedish University of Agricultural Sciences, SLU
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Supervisor:	**Pia Nilsson, Swedish University of Agricultural Sciences, Department of Economics: Agricultural and Food Economics**
Examiner:	Rob Hart, Swedish University of Agricultural Sciences, Department of Economics: Environmental and Natural Resource Economics

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Swedish University of Agricultural Sciences
Faculty of Natural Resources and Agricultural Sciences
Department of Economics

Abstract

The marine resources have under a long time been exposed to mismanagement and lack of joint sustainability practices, this has resulted in overfishing and depletion of fish stocks. This paper aims to combine European sustainability policy with trade analysis concerning Norwegian fish exports to the EU. The underlying hypothesis is that policy governing sustainable development has led to a strengthening of European aquaculture. The policy chosen for the study is the Common Fisheries Policy (CFP) and its reforms in 2003 and 2013, where it aims for economic, environmental and ecological sustainability.

This paper implements a Gravity Model to combine the CFP together with common trade variables such as bilateral agreements, distance, CPI, GDP and trade openness. The analysis is made for both Norwegian fish and salmon exports to a sample of 12 EU countries between 1995-2015. The EU's trade relation with Norway is of interest since they are one of the major fish exporters globally and the most important fish supplier for the European market. The results suggest that the CFP could have affected the sustainable development of the EU aquaculture, and especially in terms of salmon. The trade agreement variable for EEA is also suggested to have a positive influence on the Norwegian fish exports during this time period. The results also indicate that an increase of aquaculture in the EU would not be at the expense of Norwegian fish trade. This paper provides an example of how a simple Gravity Model could be used in order to combine sustainability policy and trade analysis.

Keywords: Aquaculture, Gravity model, EEA, European trade, Common fisheries policy, Natural resource economics, Food economics

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Abbreviations

EU	European Union
EEA	European Economic Area
ECDPM	European Centre for Development Policy Management
CFP	Common Fisheries Policy
CAP	Common Agricultural Policy
CPI	Consumer Price Index
EFTA	European Free Trade Agreement
CEPII,	Centre d'Etudes Prospectives et d'Informations
EMOFA	European Market Observatory for Fisheries and Aquaculture Products
MSY	Maximum Sustainable Yield

Introduction

Fish and seafood products are a highly traded good with a large economic importance globally. It is expected that the total worldwide demand for fish and seafood will reach 155 million tons by 2050 (Naylor and Kishore et al. 2021). This would be a doubling of the consumption compared with 2015. The underlying reason for the increased demand is expected to not merely be because of population growth but also to shifts in people's dietary preferences. Meanwhile annual wild stock captures have stagnated and struggled to keep up with increasing demand (European Centre for Development Policy Management 2006). Overfishing, climate change and the complexity of natural resource management or shared sustainability practices have all hampered the supply of wild fish (ibid.). That is something which is projected to have an impact on the resilience of fishing environments in the future. This could also impose additional restrictions on the fishing business and its supply globally (Naylor and Kishore et al. 2021). Increased demand, technological progress and larger fishing fleets have affected the EU's fish sector as well (Hentrich and Salomon 2006). Overfishing and the fact that fishing stocks have been unable to rebound at the same rate as they were fished have resulted in a rapid decline since the mid-nineteenth century. It was not until the 1990s when the EU first developed common management measures like quotas, protected areas or restrictions on fishing methods. This was done mainly to conserve European fish populations, but also to ensure the fishing sector's long-term survival.

The future of the fish stocks in European waters is unclear, as the vast majority of the seas are still considered overfished. For example, the Atlantic cod population has a large economic importance for both the EU and Norway's fishing sector, but with quantitative reproduction levels well below critical (WWF 2006). This is assumed to be the outcome of inadequate marine wild stock management, as well as the reality that the resource will be exploited as long as it is still profitable (Hentrich and Salomon 2006). The European fish stocks face an underlying problem in terms of overfishing and finding a maximum sustainable yield (MSY) that enables regrowth in both the short and long term (Symes 2001). This could be due to the fact that the European fish sector has lacked adequate policies and measures to contain the welfare. The policies that are in place therefore need to be evaluated, and the question is whether the Common Fisheries Policy (CFP) has met its target.

There are researchers such as Gephart et al. (2021) and Teletchea and Fontaine (2012) who claim that an expansion of aquaculture is necessary if we intend to meet people's demand for fish at all. Based on the same premises as the domesticated animals in agriculture. They claim that aquaculture is necessary for a sustainable approach when taking responsibility for marine wildlife and to avoid problems that are related to fisheries. There are also previous studies in place evaluating the success of the CFP and other EU fish regulations on conserving marine resources. For example, the study presented by Hentrich and Salomon (2005) and Symes (2001) where they conclude that the current policies in place have not helped the fish industry's long-term sustainability, but that the focus rather lies on short term socioeconomic factors.

The first aim of the paper is to apply the Gravity Model on fish as a single commodity in order to analyze the effects of the EU sustainability policies. Trade- and trade restriction analysis on single commodity groups is not an uncommon approach in the economic literature when examining how it affects demand. Studies such as Sissener (2005) have examined Norway's role as a major fish and salmon exporter both inside and outside of Europe when facing different market barriers. Both in terms of how different trade agreements have been an important part of Norway's economic development, and in terms of how the fishing sector is affected by the growing aquaculture sector. Studies such as Gephart et al. (2021) have examined the exploitation of the EU fish stocks, and how the fish sector is connected to various problems regarding joint management.

The second aim of the paper is also to investigate if the EU fish policies have influenced Norwegian exports to the EU. This paper therefore aims to combine the economic importance for the Norwegian and EU economies with common sustainability policy and aquaculture. This was done in order to see how the policy had affected the development of Norwegian fish trade and EU’s domestic aquaculture between 1995-2015. The underlying hypothesis is that the CFP has led to a strengthening of domestic aquaculture in the EU. It would therefore also be interesting to see how that has correlated with the existing fish trade with Norway.

The paper is built on a data set containing trade variables such as GDP, distance, CPI, population and trade openness for 12 EU countries. These countries were selected on the terms that they both had domestic aquaculture production and imported Norwegian fish during this period. The time series was chosen to capture how trade factors affected imports and domestic production over time. They were also chosen based on how the CFP’s reforms from 2003 and 2013 would interact with the other variables. This methodology is applied both on fish in general and for salmon specifically in order to see if the analysis varies due to the aggregated level. The specified model for salmon is of interest foremost since it is the single most important species for Norwegian exports. It is also a common species in aquaculture, enabling comparisons both between species and between production forms.

The main findings in this paper seem to point towards that sustainability policies such as the CFP have had an effect on both Norwegian fish exports and aquaculture in the EU. The most conclusive results are given for the CFP reform from 2003 and in terms of salmon. The results also suggest that an increased domestic aquaculture production is not made at the expense of Norwegian fish exports to the EU.

The papers following chapters will give further background into the underlying trade and policies agreements relevant for this work. Furthermore, a presentation of the underlying economic theory and models used for this paper is given in the method section. Models and calculations will be presented in the data section. Results and major findings will be presented in the results section, followed by a discussion of how these results can be interpreted in the light of this work.

1. Background

This section is designed to highlight why both the relation between EU and Norway is of interest, and the significance of policy management.

1.1 The Norwegian Fish Industry

The case of Norway is particularly interesting since they account for a substantial portion of the fish exported globally (Regjeringen 2018). The favorable conditions along with the long coastal lines adds up to Norway's major competitive advantages for both fisheries and aquaculture. The fish sector has always been an important part of the national economy (Johansen and Bull-Berg et al. 2019). The industry does bring large export revenues and important aspects of employment along the rural and remote areas in Norway. The importance was emphasized when Norway became the first country in the world to create their own Ministry of Fisheries in 1946. This has been in accordance with national politics in respect of preserving and encouraging employment and external values created due to the fish sector. It has been a sector that the Norwegian government has wanted to safeguard due to the national importance and evade joint legislation (ibid).

Norway has been a world leading actor in aquaculture since the 1970s and it is today the fastest growing value chain in the entire Norwegian fish industry (Johansen and Bull-Berg et al. 2019). An industry that is expected to grow even further due to technology adaptations and a broader diversity of farmed species. The farming of Atlantic salmon is not only the most important species for the export volumes, but also the largest in terms of export value. In 2010 the exported salmon amounted to a value of 31 billion NOK. By 2021 this number had grown to a noteworthy 81 billion NOK (Statista 2022). The aquaculture production of Norwegian salmon is predicted to reach a growth factor of five by the year 2050 (Olafsen and Winther et al. 2012).

Figure 1 illustrates how the Norwegian fish exports are distributed in terms of origin divided into aquaculture and fisheries. The data illustrates how the share of farmed fish has increased in the last decade, while fish origin from wild habitats have stagnated. The values are presented in 1000 NOK.

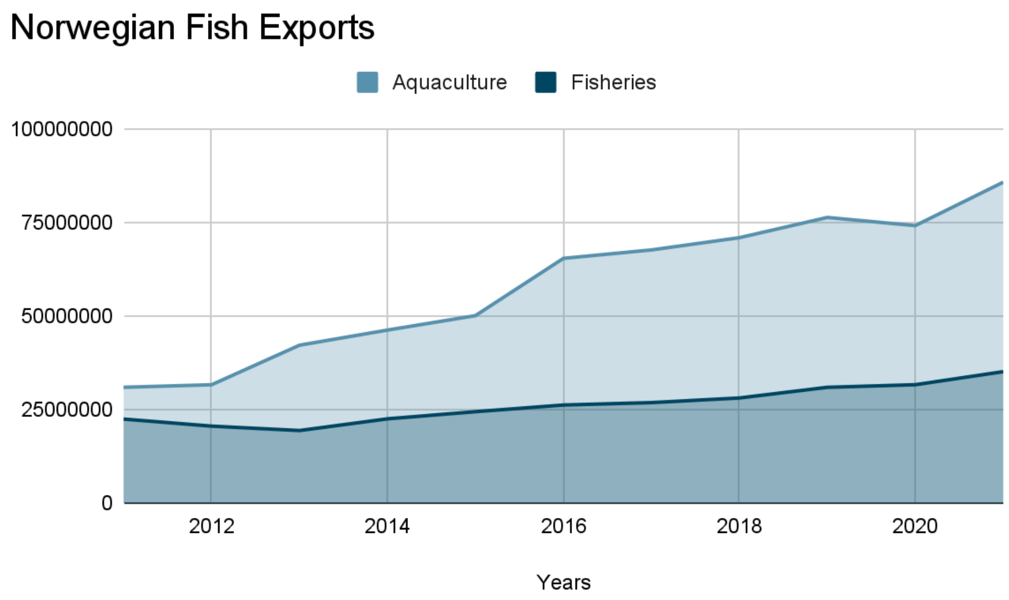

Figure 1: Total fish export from Norway during the last decade (Statista 2022)

Figure 2 illustrates the share of Norwegian fish exports that consist of salmon. The data illustrates how the share of salmon has parallelly increased with total fish export in the last decade. Values are presented in 1000 NOK.

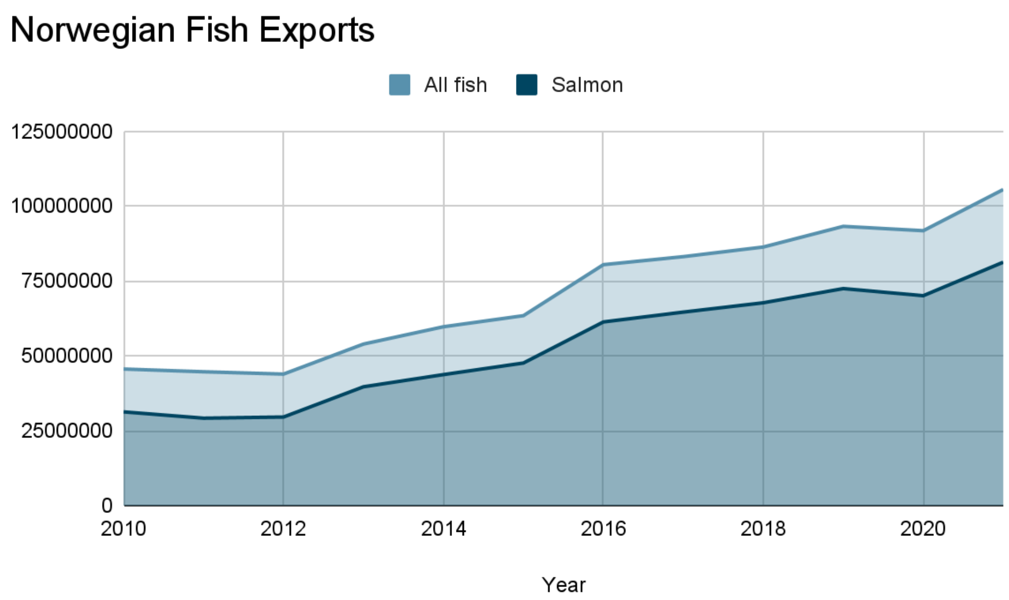

Figure 2: Total value of Norwegian fish exports during the last decade, showing the relation between all the fish and salmon (Statista 2022a, 2022b)

A majority, i.e., around 60 % of the Norwegian fish are exported to the EU market.

From an EU perspective, Norwegian imports constitute a share of around 26,5% (in 2020) of total fish imports (European Commission 2022a). This places Norway as the EU's single most important fish supplier. This emphasizes the economic importance of bilateral trade between the two parties.

1.2 Trade Agreements and EU Policy

The European Union emerged after the second world war in the 1950s, and it has ever since developed to become a vast trade network (EU 2022). The entity covers 27 countries and hence large parts of the European continent and has trade agreements with nearly every country in the world. Trade within the EU is governed by a series of EU treaties, all of which have as their primary goal the removal of trade barriers between its members, resulting in the creation of an internal market. In this market goods, services, people, and capital should be able to move freely between the allied countries (EU 2022). The Treaty of Rome was the first to establish a unitary fishery policy (European parliament 2022). It was first related to the common agricultural policy (CAP), but as time went on, it became increasingly self-contained. The common fisheries policy (CFP) has had as its principal goal since its amendment in 2002 to ensure that fishery resources are used sustainably and that fishermen have a guaranteed wage and stable job in the long term. In 2013, the Council and Parliament decided on a new shared fisheries strategy to ensure that fisheries and aquaculture activities are long-term environmentally, economically, and socially sustainable.

Two examples of EU external trade agreements are the European Free Trade Agreement (EFTA) and the European Economic Area (EEA). Norway, Switzerland, Iceland, and Liechtenstein are members of the EFTA, which was established in 1960 (EFTA 2022). The trade agreement was established to enhance bilateral trade and economic integration among non-EU nations through a shared framework. In order to create a single internal market, the EEA agreement brings together EU and EFTA countries. Where all parties are bound by the same basic regulations, allowing free movement of goods, capital, services, and people across the region (European Commission 2022). Along with a raft of common rules and laws covering, among other things, competition, transportation, and the environment. These agreements, particularly the EEA, have proven to be extremely important for economic integration. For some countries, such as Norway, they have been utilized as an alternative or substitute for EU membership.

The EEA agreement, however, does not cover the agricultural sector or fisheries, but there are some commitments addressing agricultural and aquacultural commodities trade in other articles and agreements. As a result, even if they are EEA members, Norwegian fisheries products do not face an entirely open and free market and will be charged accordingly. However, other export commodity groupings, such as halibut, saithe, haddock, and cod, continue to experience lower or no trade obstacles (Sissener 2005). But, when it comes to salmon, Norway has a history of being accused of dumping by European salmon farmers between 1989 and 2004. That was the motivation behind the 1997 anti-dumping agreement between Norway and the EU, which established an export charge and a minimum import price to protect the EU's internal salmon market. Up until 2003, this resulted in a decline in imports of around 13 percentage points. The looming possibility of new trade restrictions against Norwegian salmon could jeopardize cost-effective production and could be deemed a trade barrier. In this thesis these factors will be included in order to examine how these limitations in the EEA have affected fish imports from Norway.

1.3 Literature Review

This subsection aims to provide further depth to the issues at hand. It is also reviewing what earlier studies have done in the field, and how this paper fits into that research.

1.3.1 Combining the Gravity Model with Policy

The initial idea of this paper's research design came from earlier studies employing the gravity model in an EU context. Belash and Ogandzanjana (2021) wrote a study on how the EEA trade between the EU and Norway works, which set the groundwork for the gravity model technique used in this paper. Linderfelt and Norell (2019), for example, employed the gravity model to investigate how free trade agreements enhanced Swedish exports. In addition, work on how the gravity model could be used to analyze the possibility of Norwegian fish exports to Europe was presented by Krutskykh (2012). Together with a paper by Hammarlund (2011) for the AgriFood Economics Centre, in which the gravity model was used to investigate the impact of trade restrictions on domestic agriculture and imports into the EU. These studies all show the diversity and the wide possibilities that the gravity model has when analyzing trade relations. They all serve as a foundation to the selection of classic trade variables that are included in this paper's models. But where there lack further aspects connected to the European fish trade and incorporation of policy.

Sissener (2005) on the other hand investigates the impact of trade restrictions within the EEA on the Norwegian salmon business. They conclude that by lowering tariffs, other non-tariff trade obstacles, such as precautionary anti-dumping laws, have increased. It is important to note that commerce is hampered not only by traditional trade barriers, but also by other informal causes. These unofficial trade barriers are costs associated with market expansion and may be caused by; policies, a lack of information, a lack of network, or a lack of experience. A trade barrier that has influenced the trade relation between Norway and the EU is the Salmon Agreement signed in 1997. Norway was accused of price dumping and did not want to face anti-dumping procedures as a consequence. Between 1997 and 2003, Norway's EU market share was severely reduced due to a minimum import price and a tariff. Since the agreement's termination, new safeguards have been put in place to decrease Norwegian salmon supply, and to protect salmon farmers in the EU (Sissener 2005). The paper by Sissener (2005) provides significant insight into how the two parties both tried to safeguard their own domestic fish sector, despite the EEA. The paper also contributes to the insight that the termination of the Salmon Agreement in 2003 might have collateral effects on this paper's analysis of the CFP, due to lagged effects.

1.3.2 The European Fish Sector in a Sustainability Aspect

In comparison to other foods, Gephart et al. (2021) gathered the external environmental effects that are induced by varied fish production and fisheries in a big global study, considering the environmental impact of aquatic food systems. They emphasize that environmental variables such as greenhouse gas emissions, nitrogen, and phosphorus must be considered in addition to production limitations such as land and water consumption. Merino et al. (2012) also highlight the problems of balancing sustainable supply expansion, growing demand, and environmental and natural resource stress but from an EU viewpoint. They emphasize the importance of boosting the worldwide supply of fish and seafood, not only to fulfill demand in a sustainable manner but also to ensure global human health and nutrition. They come to the conclusion that both types of production have advantages and disadvantages. Their general conclusion regarding aquaculture is that it could have little influence on the environment given the right circumstances. That it could outperform other domesticated production like chicken, which is regarded as the most efficient land-based source of animal protein. As a result, this paper is critical for a better knowledge of the environmental potential of fish and seafood, reducing some of the strain on the world's food systems (Gephart et al. 2021). In this paper the increased aquacultural activities over time will be interpreted as a sustainable development in the fish sector. Something that would be in line with the aims of the CFP.

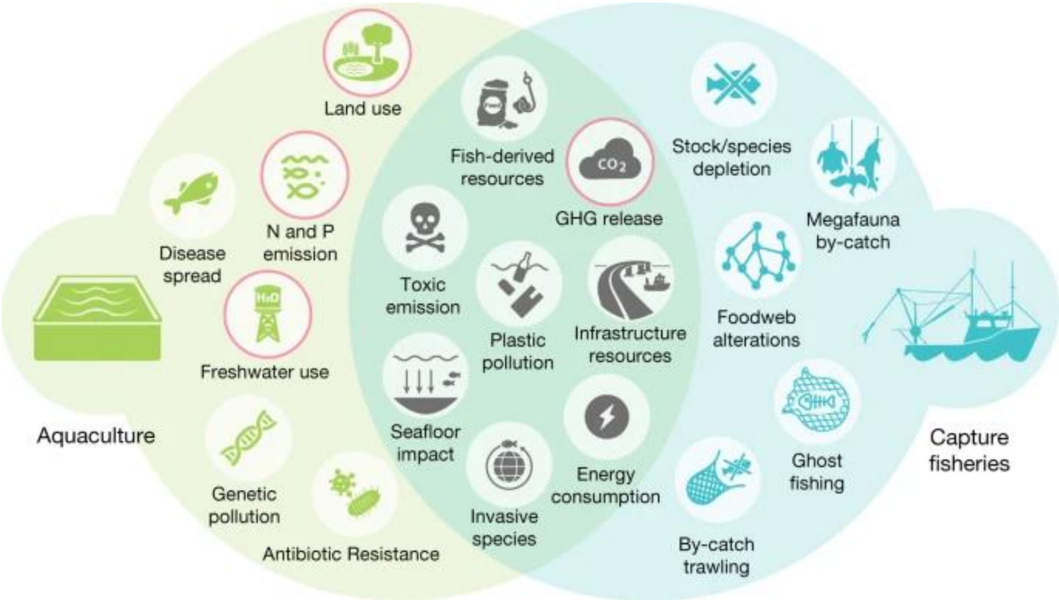

Figure 2: Major stressors stemming from aquaculture and capture fisheries. (Gephart et al. 2021:362)

The profound report, requested by the European Parliament's Committee on Fisheries (Bostock et al. 2009), explores how EU aquaculture competitiveness has evolved while facing imports and global supply. They show that it is the EU policies that govern aquaculture, and that all investment in aquaculture is more or less invested in domestic expansion. Nonetheless, they observe that the gap in fish demand is filled by external imports rather than an increase in domestic production. They come to the conclusion that policies must be designed with the entire market and value chain in mind, as this is what genuinely governs production. Furthermore, the key issue that shapes the overall aquaculture industry in the EU is trade and trade restrictions governing imports. Whether or not the EU aquaculture sector can compete with imported fish and seafood is due to the design of the trade policies (Bostock et al. 2009). This is something that Asche et al. (2008), who have done more study on the consumer perspective, also emphasize. Even if the consumer perspective is excluded in this paper, they still present important aspects that might be underlying for the entire fish market in Europe. They conclude that the market relationship between farmed and wild fish is still difficult to eradicate. It is difficult to predict if farmed fish will gain market shares, since farmed fish rather appears to develop its own market sector. It is therefore likely that farmed fish is not a given substitute for wild fish (Asche et al. 2008). This aspect is of relevance when creating policy that advocates aquaculture, since it might not help wild stocks recover as intended, and economic resources might be better allocated.

The gap between expensive policy regulations and actual change is something that Hentrich and Salomon (2005) looks at. They examine how EU fishing regulations failed to achieve sustainable fishing management during the last couple of decades. For example, how they are solely based on exorbitant subsidies and short-term socio-economic goals rather than focusing on long-term preservation. The long-term economic goals could be achieved by boosting fisherman accountability, injecting transferrable fishing rights, and reducing fishing fleets. They also are accusing the CFP of failing to achieve its purpose of ecological, social, and economic sustainability. Their goal is a revision of the existing CFP, with flexible fishing limits and individual fishing rights being preferable in terms of reducing many of the industry's negative effects while simultaneously increasing its profitability. Emphasizing that if a policy is intended to target the conservation of marine resources, it will require real incentives if it is to succeed (Hentrich and Salomon 2005). Symes (2001) also presents a major critique against the CFP policy for the first two decades that it existed, before the reform in 2003. The study thoroughly presents many points where they believe that the policy has failed and advocate dramatic changes to the CFP before the upcoming reform in 2003. Symes (2001) highlights how political reforms must be based on knowledge and scientific data and that sustainability cannot be fixed by short term crisis management. This study contributes to better knowledge of how the underlying expectations were for the CFP reform in 2003.

2. Method

In the following chapter the economic theory regarding the Gravity Model is presented and how it is adapted into this paper.

2.1 The Gravity Model

For almost 60 years the gravity model has been an important instrument for analyzing and evaluating international trade flows (Bussiére et al. 2008). The gravity model has been the empirical backbone for trade assessments particularly in light of expanding global integration and international trade. The application of the model has risen considerably in recent decades, something that is believed to be due to the continuous expansion in the theoretical foundation. With increased globalization and international trade, appropriate economic instruments to conduct trade policy and quantitative analysis are becoming increasingly important. One of the model's numerous advantages is that it is a relatively intuitive tool with solid theoretical foundations and a very flexible structure, making it applicable to a wide range of economic areas concerning trade. The model's strong prediction capacity is another feature that makes it ideal for empirical policy analysis in terms of goods and services (Bussiére et al. 2008).

The gravity model was primarily presented and developed in the 1960s by Jan Tinbergen but has since evolved into a variety of other shapes and forms. The model is based on Newton's law of gravity, which states that an object's gravitational pull is proportional to its mass and distance.

$$F_{ij} = G\frac{M_i^1 M_j^2}{D_{ij}^3} \qquad (1)$$

The same fundamental reasoning can be seen in the economic context. The model employs economic size and country size to explain the mass variable (M) and, as a result, the gravitational attraction of trade (F). Along with the countries' distance from each other (D). The distance negative impact on the pull of economic connection is due to more friction in trading, such as longer and more expensive trade costs. Together with the fact that crossing borders usually entails a further delay or tolls. Something that often is captured in the empirical work by a dummy variable. Other factors, such as increasing GDP, population growth, trade openness and trade agreements are all examples of factors having a positive effect on bilateral trade. A variable such as GDP (M), especially presented in terms of per capita gives us a good insight in the purchasing power of the people. Which in turn stimulates trade. The same goes for the population growth, the larger the consumer circuit gets the larger the possibility of expanded trade and increased consumption. The larger the population and the higher purchasing power - the higher is the demand for goods. Especially the type of goods that can be associated with a higher income or seen as more luxurious. An example of such a category of goods where we can see an increased demand as the people become better off is common when it comes to foods. Particularly for foods associated with a high value of proteins such as meat and fish (Yotov et al. 2016).

Many economists have since then added depth to the model over time by introducing variables that give larger perspectives and areas of application (Yotov et al. 2016). Different dummy variables are often included to help account for crucial elements such as common language and cultural commonalities, which are equally explanatory in terms of trade. This helps us to better grasp the underlying theoretical framework and to interlink it with empirical work and data (Yotov et al. 2016). In terms of trade in fish and seafood Natale et al. (2015) presents a version of the model where variables for seafood are additionally added. They highlight that it is an important model development in order to create accurate policies in this area. In this thesis a similar model will be presented, but with the contribution of examining fish imports from Norway to the EU in particular instead of a bilateral trade relation.

2.1.1 The Gravity Model and Comparative Advantages

The Theory of Comparative Advantages is an economic framework developed in the 19th century by an economist named Ricardo (Britannica 2022). The theory advocates production specialization along with free trade implementation. It is a well-known and often applied theory for both explaining and substantiating global trade. It demonstrates how production and geographical conditions differ between countries. And that if a country can manufacture a good more efficiently and at a lower opportunity cost, everyone benefits. Instead of squandering resources on inefficient production, and rather than that every country should produce all of its own goods. Allowing that country to focus its resources on a more focused and productive production that is more relevant to that country. Producing lower-cost items around the world, where resources and conditions can be sufficiently allocated. This is also the rationale behind how liberalizing trade can help a country's economy grow and even raise it out of poverty or lower socioeconomic standards (Schumacher 2013).

One of the major critiques towards The Gravity Model is that it does not take comparative advantages into consideration. Something that Ciuriak and Kinjo (2006) highlights as something that should not be discarded when wanting a full picture of global trade flows. Calling the theory of comparative advantages ‘the bedrock’ for the economic perspective of international trade. However, the theory of comparative advantages is not without questioning. Urged by Schumacher (2013) to lack the empirical anchoring that it should have for a theory so widely recognized and applied. He warns against constructing policies based on this theory since it lacks the empirical backing necessary to create a good and dependable policy with a predetermined desired effect (Schumacher 2013).

2.2 Applying the Gravity Model

Even if Norway experiences favorable conditions in their fish industry that could be interpreted as comparative advantages in production the main goal by applying the gravity model is to examine their gravitational pull towards the EU market. Theoretically, both Norway's large economic activity in the sector, being one of the largest global exporters, as well as a geographically close neighbor speaks for a high economic integration with the EU. The model also enables as of for in this case to include additional trade variables that can be included in the analysis such as a policy variable. This extends the model to include indirect trade variables that could have had an effect on how the trade flows have altered over time.

3. Data

This paper is based on panel data compiled for this research. The quantitative technique was used to enable the employment of a gravity model, which has various advantages for interpreting international trade relations (Yotov et al. 2016). The utilization of a panel data set enabled the data to reflect changes in several countries over time

Variables such as GDP per capita, distance, inflation rates, population growth, trade openness, trade agreement, and common border were used as fundamental trade variables in the model as presented by Yotov et al. (2016) and Belash & Ogandzanjana (2021). The data set variables were compiled from a variety of sources, including CEPII, EMOFA, and The World Bank. Norwegian fish exports were set as the dependent variable in order to see how the independent variables affected the level of exports over time. The data on the Norwegian fish exports for each EU country was provided by the Norwegian Central Bureau of Statistics. The general form of the estimated gravity model can therefore be expressed as following:

$$ln y_{ijt} = \beta_0 + ln x_{it}^A \beta_A + ln x_{it}^C \beta_c + \varepsilon_{it} \qquad (2)$$

where y_{ijt} denote the log of imports of Norwegian fish (denoted j) to country i at time t, x_{it}^A denote domestic aquaculture production in country i at time t and β_A denote its coefficient estimate, x_{it}^C denote a vector of the relevant control variables and β_c denote a vector of the associated coefficient estimates. Furthermore, ε_{it} denote an idiosyncratic error term.

In order to indicate joint trade and EU membership, dummy variables for EEA trade agreement membership were constructed and added to the general model. A dummy variable for fishery policy was also implemented for the years 2003 and 2013 to reflect any changes due to the CFP's reforms for those specific years.

3.1 Delimitation

The first delimitation when creating the panel data set was to set a 20-year time frame from 1995 to 2015. This delimitation has two key reasons. Firstly, most of the EU's role in policymaking, trade ties, and natural resource conservation may be captured during this time period, without the disturbance of lagged effects. Many common reforms were introduced, and many nations joined the EU during this time, allowing for the analysis of the effects of EU membership before and after. Second, because the purpose was to capture trade and policy effects rather than effects due to Brexit and the Corona epidemic in 2019 and 2020. Making it beneficial for this study to be set in a more historical viewpoint, excluding recent years.

The second delimitation was made to select a sample of EU countries for the study, which was done in two steps. Firstly, by establishing which EU countries imported Norwegian fish and secondly which had domestic aquaculture production throughout this time period. Countries who did not join the EU or did not engage in aquaculture between 1995 and 2015 were removed. This was done to establish a more homogenous sample that could be used to study the impact of trade and policy factors on both imports and output.

3.2 The Regressions

The regression trials were conducted in the software program STATA, using pooled OLS regressions and robust tests. All variables were logarithmized to reflect relative effects, and to enable the usage of different currencies or units. Additional tests, such as VIF tests and control variables for the financial crisis in 2008, policy interactions, and anti-dumping laws in 1997, were included to control for additional influences. In the following table (table 1) the variables are presented with name, label and unit.

Table 1: List of variables included in the regression

Variable name	*Label and unit*
DIST	*The distance between the EU country's capital and Norway's capital in kilometers.*
EEA	*The European Economic Area. Serves as a proxy for a regional trade agreement as a dummy variable for membership.*
POP	*Total population for that EU country and year.*
CPI	*The Consumer Price Index for that country and year. Serves as a proxy for yearly inflation.*
GDP	*The Gross Domestic Product per capita for that country and year. To reflect the expected purchasing power by individuals. Presented in both USD and EUR.*
NF	*The country's imports of Norwegian fish. Includes fish from both fisheries and farmed. Presented in terms of value, in both NOK and EUR.*

NS	*The country's imports of Norwegian salmon. Includes salmon from both fisheries and farmed. Presented in terms of value, in both NOK and EUR.*
AC	*The EU country's domestic production of fish by implementing aquaculture. Presented as a yearly value in EUR.*
ACS	*The EU country's domestic production of salmon by implementing aquaculture. Presented as a yearly value in EUR.*
POLICY 2003	*A proxy for the Common Fisheries Policy (CFP) for European countries sustainable development of fisheries and aquaculture. A dummy variable for all years 2003-2013.*
POLICY 2013	*A proxy for the reform of the CFP for European countries fish management. A dummy variable for all years 2013-2015.*
FLEET	*The average size of the fishing fleets used for fishing, measured in gross tonnage (GT). Used as a proxy for comparative advantages and rationalized fishing.*

3.2.1 Expanding the General Model

The model was later expanded from the one in Eq. (2) to include additional variables as mentioned previously:

$$lnNF_{it} = \beta_0 + \beta_1 lnAC_{it} + \beta_2 lnGDP_{it} + \beta_3 lnDIST_i + \beta_4 lnCPI_{it} + \beta_5 lnPOP_{it} + \beta_6 lnTO_{it} + \beta_7 EEA_{it} + \beta_8 ln\underline{FLEET} + \beta_9 POLICY + \epsilon_{it} \qquad (3)$$

Where NF_{it} denote the log of Norwegian fish imports to country i at time t, AC_{it} denote domestic aquaculture production, $\ln GDP_{it}$ denote the log of the gross domestic product per capita for country i at time t. $DIST_i$ denote the distance between the capital in country i and the capital in Norway, which is time constant. CPI_{it} denote the consumer price index for country i at time t, $lnPOP_{it}$ denote the population growth for country i at time t, TO_{it} denote trade openness for country i at time t. EEA_{it} denote the regional trade agreement, $\underline{FLEET}$ denote the average fleet size in country i over the time period.[1] Furthermore, ϵ_{it} denote an idiosyncratic error term.

When the dummy variables for the CFP are added it enables for the creation of interaction between variables in the data set. Making it possible to examine how

[1]Because the fleet size variable available in Euro Stat have many missing values, we include a variable to proxy of the size of the fleet as an average measured over the time period.

policy itself would interact with i.e. domestic aquaculture in the EU or the fishing fleet size itself. The interaction command in STATA was an additional part of the regressions that presented a broader possibility to analyze how the CFP could have influenced the European fish sector. The hypothesis was that common EU fishing policy for 2003 and 2013 would correlate with both fishing and aquaculture. Since the policies regulate for sustainable management and rules regarding fishing quotas, they were expected to have some negative effect on the average size of the fishing fleets and the total Norwegian fish imports. This is even if Norway is not an EU member, since they are included in most of the common fishery agreements regarding aquatic management. Therefore, the policies were also expected to have a positive correlation with aquaculture, since they could be seen as a more sustainable complement of fish production. The same is applicable for variables like the consumer price index (CPI), which serves as a proxy for inflation, and the distance variable, which are both projected to have a negative impact. While indicators like GDP per capita and population growth were supposed to represent the country's purchasing power and increased import demand. With an estimated positive relation between stronger demand and higher imports.

3.2.2 A Specified Model for Salmon

As mentioned previously in this paper salmon plays a central part in terms of both economic values, exported volume and importance in aquaculture. Since the trade relations with Norway is the essence of this study, a specified model containing data on a less aggregated level for salmon alone could provide additional insight. This is addressed by estimating the following model:

$$lnNS_{it} = \beta_0 + \beta_1 lnACS_{it} + \beta_2 lnGDP_{it} + \beta_3 lnDIST_i + \beta_4 lnCPI_{it} + \beta_5 lnPOP_{it} + \beta_6 lnTO_{it} + \beta_7 TA_{it} + \beta_8 ln\underline{FLEET} + \beta_9 POLICY + \epsilon_{it} \quad (4)$$

The equation is identical to the one in Eq. (3) with the difference that the dependent variable now measures NS_{it} which denote the log of Norwegian imports of salmon to country i at time t and ACS_{it} which denote domestic salmon aquaculture production at time t. Providing a model with Norwegian salmon imports as the dependent variable. This allows a more focused research into how policies and other external factors which have influenced Norwegian salmon exports to the EU countries over time. The idea was that the results would be similar to the results obtained for all fish but that it would have been possible to distinguish certain effects related to salmon. This type of distinguination has been made in previous studies such as Sissener (2005) focusing on Norwegian trade with salmon in a more specific context. The difference in this paper is that it interlinks Norwegian salmon exports with domestic EU aquaculture and the CFP.

3.3 Descriptive statistics

The variables utilized in the study's regressions are listed in the table below (Table 2). It contains statistics from 12 different countries during a 20-year period, depending on how much Norwegian fish they imported during that time. There are 14 different variables in total, as well as three sequences of interactions produced by combining two of the existing variables. This resulted in a total of 252 observations.

Table 2: Descriptive statistics

Variable	*Obs*	*Mean*	*Std.dev.*	*Min*	*Max*
DIST	*252*	*1769.81*	*751.4706*	*417.5658*	*3202.21*
EEA	*252*	*.797619*	*0.4025742*	*0*	*1*
lnNF	*252*	*19.03698*	*2.487332*	*13.90718*	*22.55161*
lnAC	*252*	*18.05215*	*1.504617*	*15.04369*	*20.71859*
lnNS	*252*	*18.61781*	*2.664928*	*12.47855*	*23.14249*
lnACS	*252*	*16.08119*	*2.521758*	*8.514376*	*20.66422*
lnGDP	*252*	*9.761319*	*0.9171057*	*7.216263*	*11.03469*
lnDIST	*252*	*7.365311*	*0.5204544*	*6.034442*	*8.071596*
lnCPI	*252*	*0.9508681*	*1.185019*	*-3.283031*	*6.964489*
lnPOP	*252*	*16.46817*	*1.196188*	*13.65931*	*18.01344*
POLICY 2003	*252*	*0.6190476*	*0.4865873*	*0*	*1*
POLICY 2013	*252*	*0.1428571*	*0.3506235*	*0*	*1*
lnFLEET	*252*	*8.818383*	*4.2954*	*0*	*12.7808*

4 Results

The regression results obtained from the general model concerning Norwegian fish (see Eq.3) and salmon (see Eq.4) exports to the EU is presented in this chapter. Along with regression analysis and interpretations of the derived results.

4.1 Determinants of Norwegian Fish Exports

The outcome of the five pooled regressions concerning all fish are presented in Table 3. Model 1, 2 and 5 yielded the most significant variables as well as a statistically significant relationship between Norwegian exports and domestic aquaculture. The variables governing policy, GDP, and EEA all appear to have a positive impact on the level of Norwegian fish exported to the EU countries. The variables for distance, CPI, population, and trade openness all appear to have an overall negative impact on Norwegian fish. The trade openness variable has the greatest individual impact as well as high statistical significance. Indicating that a 1% increase could result in a 4-5 percent decrease in imported Norwegian fish. The trade agreement appears to have the second highest impact, indicating that the EEA has a 1% positive impact on Norwegian fish exports to the EU. This is in line with the report from the European Centre for Development Policy Management (2006) that says that EU countries import from other fish producing countries when they cannot meet the demand on fish supplied from their own waters. Although the other variables have relatively low coefficient estimates, they nonetheless provide valuable insight on how they influence the level of Norwegian fish exports.

Table 3. Regression results from general model: Imports of Norwegian fish

	Coeff.	S.E	Coeff	S.E	Coeff.	S.E	Coeff	S.E	Coeff.	S.E
	Model 1		Model 2		Model 3		Model 4		Model 5	
Aquaculture	0.250***	0.087	0.127*	0.075	-0.125	0.105	0.119	0.078	1.368***	0.396
GDP	0.185***	0.064	0.038	0.063	0.012	0.066	0.037	0.063	0.010	0.065
Distance	-0.990***	0.127	-1.011***	0.121	-0.942***	0.130	-1.007***	0.123	-0.867***	0.126
Consumer Price Index	-0.403***	0.087	-0.428***	0.080	-0.458***	0.082	-0.427***	0.081	-0.434***	0.085
Population	-0.321**	0.159	-0.110	0.138	-0.047	0.137	-0.109	0.138	0.065	0.158
Trade Openness	-4.805***	0.363	-4.501***	0.369	-3.911***	0.399	-3.978***	0.402	-3.789***	0.407
EEA	1.104***	0.252	0.868***	0.268	1.202***	0.275	0.890***	0.275	0.679***	0.259
Policy 2003	0.191	0.162	0.281*	0.161	-5.225***	1.566	0.276*	0.161	0.312*	0.160
Policy 2013	0.592***	0.236	0.504**	0.231	0.415*	0.231	-0.354	2.237	0.468**	0.224
Fishing Fleet Size			0.097***	0.028	0.091***	0.028	0.097***	0.028	2.174***	0.618
Policy 2003 x Aquaculture					0.301***	0.082				
Policy 2013 x Aquaculture							0.047	0.115		
Fishing Fleet Size x Aquaculture									-0.118***	0.035
Constant	45.726***	3.534	41.744***	3.423	44.526***	3.334	41.808***	3.443	15.926*	8.210
R-squared	0.823		0.832		0.838		0.832		0.840	

Notes: *p< 0.1, **p <0 .05, ***p <0 .01

The domestic aquaculture for these EU countries does not appear to have a negative impact on the demand of Norwegian fish. The policies for 2003 and 2013 appear to have an influence on both Norwegian fish and domestic fish production, but the tendency varies depending on the model. As seen in Table 3: Model 1 and Model 2 the policies seem to have a positive impact in the more general regressions. The influence from the CFP appears to change when the interaction effects and the variable for the average fishing fleet size are added to the model. When the interaction between Policy 2003 and aquaculture is made, as shown in Table 3: Model 3, the policy variable generates an estimation of -5.225 on fish exports. When segregating the policy's influence on fish imports and domestic aquaculture, the high statistical significance indicates that the policy could have led to an decrease in Norwegian fish to the EU. As a result, domestic aquaculture increased by a small but statistically significant amount. This finding could be in line with the predetermined goal of the CFP. This highlights the contribution of this paper, interlinking domestic EU policy and aquaculture with Norwegian fish exports. When interacting aquaculture with the Policy 2013 variable, the same reasoning is presented, but with no statistical significance.

The average size of the fishing fleets has a small but significant correlation with Norwegian fish exports to the EU. This could indicate that as the size of the fishing fleets grows, so does the production supply, and by extension the imports of fish. The variable could therefore be interpreted as a proxy for rationalized fishing in the EU.

4.2 Determinants of Norwegian Salmon Imports

The regressions based on the specified model for salmon showed an overall better statistical significance for all variables. However, there is less correlation between Norwegian salmon exports and domestic salmon aquaculture in the EU when implementing the specified model. There are also no significant results indicating any influence from population growth or fishing fleet size. The major difference moving from the general to the model specific for salmon is that GDP values improve, showing positive and significant coefficient estimates. This is consistent with the gravity model's foundational reasoning, as well as the factors of distance, inflation and trade agreements. This indicates an appropriate model selection and fit for the research, as made in the papers by Krutskykh (2012) and Hammarlund (2011).

The policy variable from 2003 also performs better in the salmon model. This suggests that the policy has affected Norwegian salmon exports into the EU. Salmon is indirectly incorporated in the general model, which could also have altered the general model's underlying implications. Furthermore, when creating the interaction between policy 2003 and domestic salmon aquaculture is included, it indicates a negative impact on Norwegian salmon exports as well. Another factor that could have impacted the year 2003 specifically, and not be due the policy itself, is the termination of the anti-dumping agreement implemented on Norwegian salmon exports (Sissener 2005). That could have contributed to the negative effect seen on domestic EU aquaculture when the interaction for 2003 and aquaculture was made, if it meant a temporary increase of Norwegian salmon imports. This is something in line with what Bostock et al. (2009) highlights, that there could be tendencies to increase fish imports instead of increasing the domestic aquaculture.

Table 4. Regression results from specified model: Imports of Norwegian salmon

	Coeff. Model 1	S.E	Coeff Model 2	S.E	Coeff. Model 3	S.E	Coeff Model 4	S.E	Coeff. Model 5	S.E
Aquaculture Salmon	0.072	0.050	0.045	0.069	-0.129*	0.072	0.032	0.068	0.045	0.108
GDP	0.312***	0.081	0.289***	0.085	0.238***	0.087	0.283***	0.084	0.288***	0.082
Distance	-0.901***	0.125	-0.939***	0.132	-0.866***	0.135	-0.922***	0.133	-0.939***	0.132
Consumer Price Index	-0.507***	0.086	-0.512***	0.088	-0.532***	0.084	-0.512***	0.089	-0.513***	0.088
Population	0.181	0.135	0.227	0.161	0.187	0.156	0.222	0.162	0.229	0.182
Trade Openness	-4.101***	0.394	-3.952***	0.508	-4.013***	0.488	-3.946***	0.510	-3.949***	0.529
EEC	1.018***	0.281	0.987***	0.307	1.558***	0.298	1.059***	0.301	0.987***	0.308
Policy 2003	0.539***	0.153	0.546***	0.154	-3.684***	1.023	0.528***	0.151	0.546***	0.156
Policy 2013	0.532*	0.277	0.516*	0.284	0.430	0.282	-1.086	2.108	0.515*	0.283
Fishing Fleet Size			0.022	0.047	0.011	0.046	0.019	0.046	0.024	0.147
Policy 2003 x Aquaculture					0.255***	0.061				
Policy 2013 x Aquaculture							0.098	0.120		
Fishing Fleet Size x Aquaculture									-0.000	0.010
Constant	35.336***	3.691	34.709***	4.039	38.136***	4.081	34.880***	4.085	34.670***	5.112
R-squared	0.820		0.820		0.830		0.821		0.820	

*Notes: *p< 0.1, **p <0 .05, ***p <0 .01*

The fact that the size of the fishing fleet does not influence the Norwegian salmon exports could be due to the fact that a majority of the Norwegian salmon is farmed in marine cages. Because fish feed made of wild fish is employed in the production, it was expected that the variable would have some impact. In this case, however, there was no significant association. The interaction between the size of the fishing fleet and aquaculture in regression 5 reflects this as well.

5 Discussion

In this section further aspects based on the work in this paper will be presented. The aim is to take the reasoning further into a deeper discussion regarding the complexity that surrounds the European fish sector.

5.1 Main Findings

It is important to highlight that these results are based on aggregated open-source data, as well as for a sample of 12 EU countries between 1995-2015. The results could have differed if the data sample was larger, including more observations and more detailed. That might have captured certain effects that were not captured in this work. Including more EU countries might also have made a more applicable analysis for the entire EU, since these results really only apply for the selected sample countries. Nevertheless, the data shows sufficient results that can give some indications regarding how European aquaculture and fisheries have evolved during this period under the influence of policy.

One variable that stood out throughout the study is the trade openness. The variable consists of exports plus imports divided by GDP, which yields a ratio that illustrates how large trade is in relation to that country's GDP. In this case the increased trade openness would generate a theoretical increase in the globalized trade of fish and seafood. Throughout the statistics in this paper that variable has consistently shown negative and significant estimates. This suggests that expanding EU countries' trade openness could have a negative effect on Norwegian fish and salmon exports to the EU. One argument is that the EU countries look to other trading partners to meet their demands. This finding is in line with Yotov et al. (2016) who shows that increasing globalization often occurs at the expense of the regional trade agreement. In addition, this finding also highlights the importance that the EEA has in terms of the regional fish trade in Europe.

For fish on an aggregated level, there is no clear evidence that domestic aquaculture in the EU would have any negative correlation with Norwegian exports. It is more likely the opposite, that an increased production could generate a higher demand for Norwegian fish products. For Norwegian salmon on the other hand, the coefficients could be seen to point towards a small but negative correlation. This is interesting from a self-sufficiency point of view and in terms of competitiveness, but no further explanation is given as to why this could be the case. To draw further conclusions, it is probably essential to examine a broader data set for salmon trade on a less aggregated level. It is hard to draw any conclusions regarding the underlying determinants of domestic salmon output in the EU, and how the salmon products differ on the common EU market. In this study, the result is interpreted as less feasible. This is partly because of the lower degree of significance level as well as it is non-recurring. It also seems to be a bit unlikely that marginally increases in EU salmon aquaculture outcompetes Norwegian salmon. Foremost since Norway is the second largest salmon exporter in the world, producing and distributing salmon in a scale that makes it harder to easily compete with. This is also an aspect that Bostock et al. (2009) touch upon.

The policy variable for 2003 showed a negative correlation with Norwegian salmon exports. This is something that stands out from the results, especially since the Salmon Agreement ended that same year. The termination of the agreement should have been positive for Norwegian salmon exports. This could be interpreted in two ways; either has the CFP made such an impact that the combined effects of 2003 still resulted in decline in Norwegian salmon. Another interpretation is that the result is misleading due to other external effects not incorporated in this data.

Another difference between the segments for all fish and salmon is that the coefficient estimates for salmon show high and consistent significance for CPI and GDP. It indicates that the salmon commodity group is sensitive to price increases and inflation. The positive correlation with GDP also indicates that salmon is demanded more when the wealth of the country and its population is increased.

5.1.1 Aquaculture: The Sustainable Way Forward

The world's population grows in both numbers and living standards, something that puts even more strain on the already strong demand for fish and seafood (Naylor and Kishore et al. 2021). Fish and seafood products are also significant from a nutritional- and food supply standpoint, as well as from an employment perspective. That illustrates the challenges and changes that the industry currently is facing. The CFP’s aim was to steer towards long term sustainability in both an environmental, economic and social aspect. European aquaculture is meant to address some of the issues that we're currently seeing, as a part of the CFP strategy. It is therefore crucial to understand how the design of the CFP and other fishery regulations affects the development of these industries, as emphasized by (Hentrich and Salomon 2005; Bostock et al. 2009; Symes 2001). This is also the reason for why the policy aspect has played a central part in this paper.

In this work the CFP variable for 2003 seems to have an impact on both domestic aquaculture and the fishing sector in Norway as well as in the EU. Especially in the case of salmon. As we can see for Model 3 in Table 3 and 4: the CFP policy could have affected European fisheries negatively, where the largest effect seems to be to all fish. The CFP could have negatively influenced Norwegian fish exports to the EU, while domestic aquaculture in the EU has benefited from the policy. If these findings were to be taken as feasible, it would be in line with the CFP goals as stated by Bostock et al. (2009). The aim was indeed to come together and safeguard marine resources while also changing the fishing sector to become more long term and environmentally, economically- and socially sustainable. This stands against the analysis that Hentrich and Salomon (2005) made regarding the CFP, claiming that short term socioeconomic aspects were met at the expense of long-term sustainability measures.

5.2 Further Work

Even if the consumer perceptions of the industry were not included in this paper's scope of analysis, it should not be dismissed. The reasons for this is foremost since it is not fitted in the general Gravity Model and would have needed a more extensive model in order to be incorporated in this study. It would be a natural extension of this subject, and something for further research. In the end, a significant portion of the production decision is based on consumer demand. Consumer perceptions about the industry and different products have a significant impact on how decision-makers choose to direct their production. Particularly in major capital-intensive industries that necessitate a significant amount of initial investment. It would have been interesting to go a step further and investigate if or how wild fish preferences may be shifted to farmed fish. For example, trade restrictions or tax on those goods, while also subsidizing more environmentally sustainable fish products.

The EU has increased fish imports to meet the rising demand (Hentrich and Salomon 2006). The question remains if our common regulations and policies are actually counterproductive. Even though it is not discussed in this study, there may be a risk that wealthy countries that require more fish and seafood products would exploit developing countries to keep production costs down. Setting high standards and having a strong regulatory framework are critical for effectively regulating the industry. However, if profitable domestic production cannot be established in the EEA area, we would likely import it from other parts of the world. This is highlighted by this paper where a negative correlation is shown between Norwegian fish exports and the trade openness variable. We are drawn to trade with those in our vicinity according to the gravity model (Yotov et al. 2016), which also means that a strengthening of the EU fish production could benefit all of Europe if done in a sustainable way.

5.3 Conclusion

This paper aimed to combine a traditional Gravity Model concerning fish trade between Norway and the EU, together with policy governing fish sustainability in Europe. The findings obtained from the regressions suggests that EU policy such as the CFP as well as the regional trade agreement EEA has affected Norwegian fish exports to the EU. The Norwegian fish exports to the EU have additionally been affected by other traditional trade variables such as CPI and level of trade openness. The analysis also differs when looking at fish on an aggregated level and when examining salmon exclusively. The two different export segments of Norwegian fish interact differently when compared with domestic EU aquaculture. For all fish there seem to be no conclusive indications that suggest that EU aquaculture negatively affects Norwegian fish exports to the EU. The Norwegian exports of fish seem to be positively correlated with the EEA trade agreement. This is underlined by the trade openness variable that indicates that both Norwegian fish and salmon exports to the EU could suffer greatly if the EU would engage in increased globalized trade, shifting away from Norwegian fish. The differences in the model specified for salmon is that estimations show that price increases would lead to a decrease in Norwegian salmon exports to the EU. It also shows that Norwegian salmon exports correlates positively with increased GDP of the EU countries. The main differences between the models is that farmed salmon in the EU seems to suggest a negative effect on Norwegian salmon exports. This paper provides an example of how policy and sustainability analysis can be incorporated into a trade model such as the Gravity Model.

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Popular science summary

There is research that states that oceans have been fished beyond the point of sustainability for a long time. It is one contributing factor to the damage that is being done to marine wildlife globally, as well as in Europe. There have not been any common EU regulations and policies in place that could reverse the negative harm done to the oceans up until the latter half of the 20th century. The EU introduced the Common Fisheries Policy in order to reach sustainability for both the marine wildlife as well as for economic sustainability for the EU fish industry. This paper uses a common trade model called the Gravity Model in order to include the policy aspect as a factor to what has affected trade and sustainability in Europe. The study analyzes how both Norwegian exports of all fish as well as salmon have been affected when sustainability measures like increasing aquaculture are made in the EU. The reason for looking specifically at Norwegian exports of fish to the EU is mainly due to the fact that Norway is one of the world's largest fish and salmon exporters. Norway is also the most important exporter of fish to the EU, supplying almost a quarter of all fish on the EU market.

The study was done with data of Norwegian exports to 12 EU countries between 1995-2015. The results indicate that when EU countries import fish from their trade partner Norway, this has no clear effect on the domestic production of farmed fish. This means that buying fish, and in particular salmon from Norway does not out-compete EU production. The results also point towards that European policy for managing the fishing at sea and protecting the oceans have had an effect on both fishing and aquaculture. This could indicate that the fishing policy from 2003 (CFP) did in some way succeed, since the aim was to stop overexploiting the sea and help Europe develop more aquaculture and sustainable production. The results also show that if the EU would for some reason open up to more global trade, importing more fish from other parts of the world instead, this would probably be at the expense of fish imports from Norway. These results are interesting in the sense that it points towards that common policy is important for sustainability.

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