NORWEGIAN SCHOOL OF ECONOMICS

Bergen, Spring 2020

NHH

Resource Rent Taxation in Norwegian Salmon Aquaculture

An Economic Analysis of Resource Rent Taxation in Norwegian Salmon Aquaculture

Simen Stien

Suprivisor: Lassi Ahlvik

Master's thesis, MSc in Economics and Business Administration,

Business Analysis and Performance Management

NORWEGIAN SCHOOL OF ECONOMICS

Acknowledgements

This thesis is written as a part of the Master of Science in Economics and Business Administration, with major in Business Analysis and Performance Management, at the Norwegian School of Economics (NHH). The thesis contributes to 30 ECTS in my master's degree and marks the conclusion of my two years at NHH.

During my studies I became interested in the Norwegian aquaculture industry. Analysing the industry has been an interesting and challenging affair. It has a great growth potential for the future and the government has highlighted the industry as an important source of tax revenue in the years to come.

I would like to thank my supervisor, Lassi Ahlvik for the support and for being my discussion partner during the process of writing the thesis. During the process the world is in a state of emergency as the COVID-19 virus has temporarily changed the way we live our lives. I must thank my girlfriend for the encouraging words and for keeping me sane during rough and difficult periods during this time.

Finally, I must also take some time to give my gratitude to both Norwegian School of Economics and BI Norwegian Business School for giving me the opportunity to live abroad in two foreign countries during my time as a student. Experiences I will forever be grateful for.

Bergen, June 20th, 2020

Simen Stien

Abstract

In 2018 the Norwegian government decided that a special tax commission should look into the possibilities to introduce a resource rent tax in the Norwegian aquaculture industry. In November 2019 the commission delivered their report with the majority proposal being that the government should introduce a periodized profit-based resource rent tax of 40 % calculated from a new special tax base called net resource rent income. In May of 2020 the Ministry of Finance discarded this proposal and instead proposed to introduce a production tax of 0,4 NOK per kg of produced salmon.

The goal with this thesis is to research if there will be any changes in the economic behaviour of the companies if one of the tax proposals are introduced. To determine if there are any behavioural changes, I will create a bioeconomic optimization model that allows me to investigate the optimal rotation time before and after the introduction of the two tax proposals. My research suggests that both the proposed profit-based resource rent tax and the production tax will distort the optimal rotation time. In both cases the rotation time lengthens which means that it represents a decrease in the marginal value of continuing a rotation. The size of the welfare loss was relatively small; 0,35 NOK for the profit-based resource rent tax and 146,75 NOK for the production tax. Although, if the production area regulations are included in the calculations the companies will be forced to harvest the biomass before it has reached its optimal size. I find that the optimal rotation time will stay at 18,08 months for production area 1-9 and 20,96 months for production area 10-13 regardless of which one of the tax proposals that are introduced. In those cases, the introduction of the taxes will not change the economic behaviour of the companies.

Contents

Tables

Figures

1. Introduction

The Norwegian salmon aquaculture industry has been through a formidable growth in the last 50 years. From a small unprofitable industry to a highly industrialized and profitable industry. A combination of expected increase in the world's population and more focus on environmentally sustainable food production gives the industry even more growth potential for the future (Food and Agriculture Organization of United Nations, 2020, p. 26). In 2018 the industry reported a profit margin of over 30 % (Directorate of fisheries, 2019a). As a result of the last few years extraordinary profit margins, the government decided that a special tax commission should look into the idea of introducing a resource rent tax in the Norwegian aquaculture industry. In November 2019 the commission delivered their proposal. Their proposal suggests that the government should introduce a profit-based resource rent taxation of 40 % calculated from a new special tax base. Expectedly this proposal has been met with big resistance from the companies within the industry.

1.1 Motivation and Purpose

During my studies I have had multiple periods as an exchange student abroad. In conversations with the locals the tax regime in Norway is often a topic of conversation. More often than not they are mesmerized by the level of taxation in Norway. Referring to the 78 % marginal tax rate for the petroleum industry. If the resource rent tax is introduced to the aquaculture industry it will be one of a kind in the world. In 2019 KPMG published a report about taxation of aquaculture in different countries and concluded that there is no resource rent taxation in other countries and there is currently no talk of introducing it either. (KPMG Law, 2019, pp. 19-20).

The debate about the resource rent taxation in Norwegian aquaculture is an interesting one where there are many arguments both in favour for and against the introduction of the tax. The topic has divided the economic professionals where it is evident that there are vastly different opinions on the subject. The proposal has been criticised by the companies within the industry. The industry participants think that the tax will alter the competitive advantages salmon farming in Norway currently possess. Arnarson and Bjørndal (2020) suggest that a potential consequence of the introduction of a resource rent tax can be that the companies might change their production cycle (Arnason & Bjørndal, 2020, p. 4). As far as I know there are limited research on this particular topic and no in depth analysis is conducted by either the industry participants, policy makers, economic professionals or special interest groups.

The goal of the thesis is to get a deeper knowledge of the Norwegian aquaculture industry and how the proposal will affect the industry if it is introduced with the terms that the tax commission and the Ministry of Finance has proposed.

1.2 Research Question

I will in this thesis answer the following research question:

"Will the introduction of a resource rent tax distort the optimal production cycles for the companies within the Norwegian aquaculture industry and what is the magnitude of the welfare loss?"

To answer this research question, I will create a bioeconomic model that calculates the optimal rotation time for an infinite number of rotations. Furthermore, I will introduce extensions to this model including the different taxes, production costs and the production area regulation constraints. By creating this bioeconomic model I can observe how the optimal rotation time changes and the corresponding profit will change with the introduction of the structure of the majority proposal from the tax commission and the proposal from the Ministry of Finance.

1.3 Structure and Restrictions

The thesis is divided into 8 chapters. Chapter 1 is the introduction of the thesis. In chapter 2 I provide an introduction to the Norwegian salmon aquaculture industry including a brief overview of the production process, historical development of the industry and growth conditions for the industry. Chapter 3 is about taxation of the Norwegian aquaculture industry. In this chapter I will go through the taxation model that is used today. Here I will also explain the two different tax proposals and how they will structure them. In this chapter I will also look at some of the arguments the industry participants have used for not introducing the tax proposals. The next chapter goes through the theoretical framework that is to be used to create the bioeconomic model and the framework of which the analysis is based on. In chapter 5 I will go through the research method used in the thesis. In this chapter I will also present and evaluate the data that I have used as input in the bioeconomic model. In chapter 6 I will setup the base bioeconomic model and stepwise add different factors and research how the optimal rotation time will be affected by the factors. In chapter 7 I will discuss the result of my analysis and also discuss potential consequences of introducing a resource rent tax by looking at the hydropower industry. And the final chapter, chapter 8, my conclusion will be presented.

2. The Norwegian Salmon Aquaculture Industry

The Norwegian coastline offers many natural advantages for salmon farming in the sea. Norwegian fjords are known for strong sea currents and oxygen-rich water that are favourable for salmon production. The fjords also provide protection from extreme weather and the sea temperature is optimal for farming. (NOU 2019:18 Eng, 2019, p. 1)

The production of salmon has increased enormous since the beginning of 1970. Today, the aquaculture industry in Norway is highly industrialized with advanced technology in every step of production. It has changed from a small “sideline business” with many small owners to a big business industry. (NOU 2019:18 Eng, 2019, p. 1) Today, the aquaculture industry is Norway’s second biggest export industry. As the industry has grown, so has the regulation of the industry changed.

This chapter of the thesis will provide a general introduction to the Norwegian aquaculture industry. After reading this chapter you will have an overview of the historical development of the industry, an explanation of the most relevant cost drivers and the production process.

2.1 About the Norwegian Aquaculture Industry

The Norwegian salmon aquaculture industry started in the 1970s but was not commercialized until the 1980s. From 1980 to today the industry have been through a massive growth process. As you can see from Figure 1 the export of salmon has increased significantly from the start in 1970. In 2016 the value of the export was over 60 billion NOK.

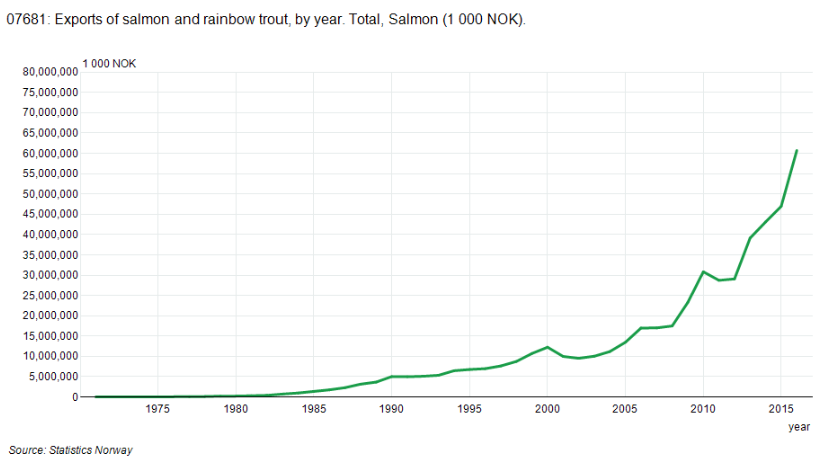

Figure 1 - Historical Development of Export (Statistisk sentralbyrå, 2019b)

During this time period the industry have changed from many small companies to big international companies that supplies big markets all over the world. In 1996 the ten biggest companies were responsible for 18,9 % of the total sale. In 2018 this number has changed to 67,3 % (Directorate of Fisheries, 2020). The biggest company, in terms of market value is Mowi ASA.

Table 1 - The Seven Biggest Aquaculture Companies Listed on the OSBEX Ranked After Market Value. (NOU 2019:18, 2019, p. 29)

Ranking after market value for all companies in OSEBX	Company	Market value. Billion NOK
4	Mowi	118
11	Salmar	49
12	Lerøy Seafood Group	37
16	Bakkafrost	31
24	Austevoll Seafood	19
36	Grieg Seafood	12
39	Norway Royal Salmon	10

Outlined in Table 1 is the seven biggest Norwegian aquaculture companies listed on the Oslo Stock Exchange. There are also many companies that is not listed on the exchange as they are private companies.

In the start in 1970 the salmon was sold in Norway. But it has developed into an export industry where over 90 % is exported every year (Nyrud, Bendiksen, & Breyer, 2016, p. 18). Export is by far the main source of income. In the Figure below you can see some of the biggest export markets for the Norwegian aquaculture industry. The biggest market is the EU with 71 %.

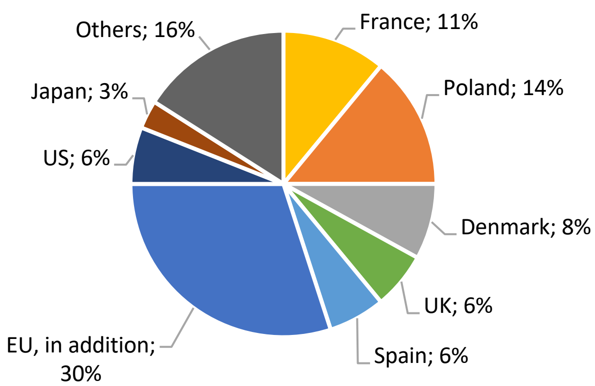

Figure 2 – Export Markets of Salmon 2018 (Directorate of fisheries, 2019b)

2.2 Economic Development

For many years the Norwegian salmon aquaculture industry had problems with their profitability. But as they gained more knowledge about the production process and became more efficient the profitability increased. New improved technology has played a major role for the success of the industry. In this section of the chapter I will introduce how the profitability has changed from the early 2000 till today. To do so I will investigate how the price, costs and currency effects have changed over time.

2.2.1 Price

The aquaculture industry is a cyclical industry where the profitability varies over time (Barentswatch, 2020). Below in Figure 3, you can see the historical development of the price per kg over the last 20 years. During this time frame the price has doubled from 30 NOK to 60 NOK per kg. Which has played a massive part in the profitability for the industry. One important reason for the increased price is due to high demand combined with limited production as a result of regulations and natural constraints like for example environmental constraints (A. Guttormsen, 2014). As you can see from the table below the price is quite volatile. A reason to the price volatility is that salmon is a perishable product that needs to be consumed in the same time period as it is harvested. Meaning that it is not possible to build an inventory and store the fish to the price has reached a desirable value. (Asche, 2011, p. 95). The price varies not only as a result of supply and demand but also the weight of the individual fish. If the fish is larger you normally can sell it at a higher price. (A. Guttormsen, 2014)

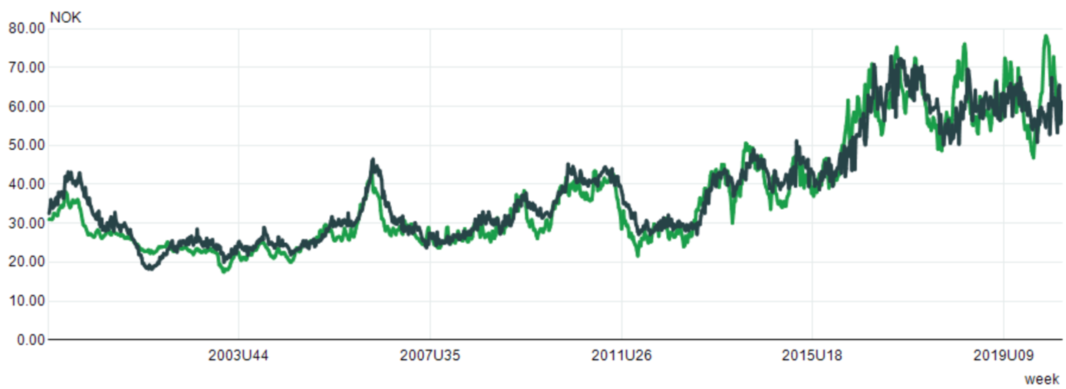

Figure 3 – Historical Development of Price per Kilo Salmon From 2000 to 2020 (Statistisk sentralbyrå, 2019a)

2.2.2 Costs

Costs in Norwegian salmon aquaculture are usually given by NOK per kg. The biggest cost drivers are feed, smolt, labour and other operation cost. Since the start in 1972 the cost has decreased drastically. One important reason to the reduction is economics of scale. Average production of salmon per permit has grown from 47 tonnes in 1982 to 904 tonnes in 2008 (Asche, 2011, p. 19). In Figure 4 you can how the production cost has developed from 2000 to 2018. In the last few years the industry has had issues with salmon lice and escaped fish. Which have been big costs in the industry. In 2018 the Norwegian aquaculture companies used 5,2 billion NOK to fight salmon lice (iLaks, 2019).

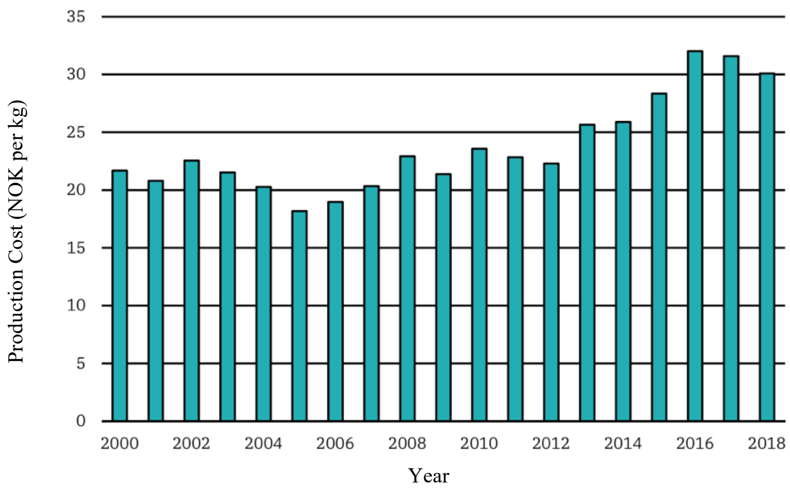

Figure 4 - Development of Production Cost Measured in NOK per kg From 2000 to 2018 (Directorate of fisheries, 2019a)

In the table below you can see the average cost of the Norwegian aquaculture companies in 2018. As you can see almost 50 % of the production cost are related to feed.

Table 2 - Average Production Cost Dissected for 2018. NOK per kg (Directorate of Fisheries, 2020)

Production costs	**2018**
Smolt cost pr. kg	3,44
Feed cost pr. kg	14,15
Insurance cost pr. kg	0,15
Labour cost pr. kg	2,80
Depreciation pr. kg	2,19
Other operation cost pr. kg	7,24
Net finance cost pr. kg	0,12
Production cost	30,09

Harvest cost incl. shipment pr. kg	3,79
Sum Costs pr. kg	33,88

2.2.3 Currency Effects

As over 90 % of the sales are generated by export, currency effects are important for the profitability in the industry. The Norwegian aquaculture companies have most of their costs in NOK but most of their revenue is generated in other currencies. Export businesses benefit if their base currency is weak towards the currency, they generate revenue in. In the time period between 2004 and 2013 57 % of the revenue came in EUR, 5 % came in GBP, 8 % from JPY, 27 % from USD. (Nyrud et al., 2016, p. 7). From 2012 to 2015 Norwegian aquaculture industry had a rise in value of 18,1 billion NOK and they estimate that 7,5 billion NOK is due to currency effects (Nyrud et al., 2016, pp. 15-16).

2.3 The Production Process

In this section I will go through the production process of salmon. An important fact about salmon farming is that compared to other species they have a high degree of industrialisation. (Mowi ASA, 2019, p. 15). There is human control on every step of the production process. From hatching of eggs, feeding, too delivery to customers. This means that it is possible to change and optimize the entire value chain.

2.3.1 Production Cycle of Salmon

Salmon is an anadromous fish (Asche, 2011, pp. 7-16). In the wild eggs are spawned and hatched in fresh water before it moves to seawater at a later stage. To replicate this, salmon production starts on land in freshwater tanks. After about one year the fish has grown into what is called smolt and are ready to be moved to seawater. The salmon stays and grows for about two years before it is harvested and distributed globally. The process is in total around 36 months. (Asche, 2011, pp. 7-16)

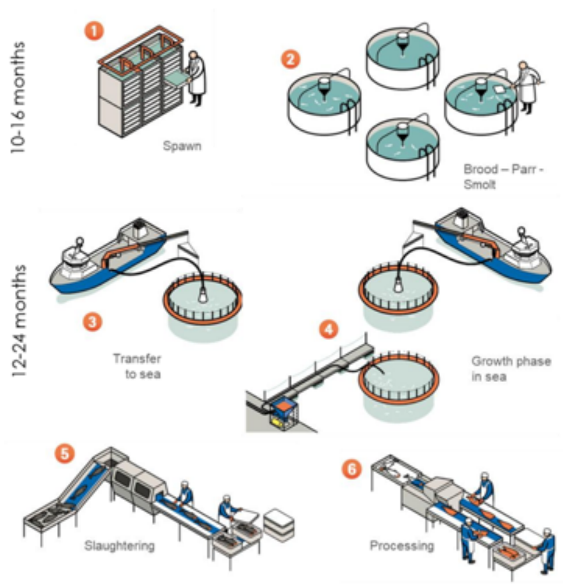

Figure 5 - Production Cycle For Salmon (Mowi ASA, 2019, p. 48)

2.3.2 Roe and Fry

The production of salmon starts in an incubator on land. The fish roe is fertilized in freshwater with a temperature of around 8 degrees Celsius for about 60 days. After the salmon has hatched the salmon fry has a yolk sack attached to their stomach where they get nutrition from. In the wild this process starts in January and salmon farmers generally follow this cycle. In the early days of the industry the mortality was were high during this process. But today the survival rate is about 70 % which represents the same survival rate as the wild. (Asche, 2011, pp. 7-16)

2.3.3 Smolt and Smolt Release

When the fish is ready to be transferred from freshwater to seawater, they have gone through a process called smoltification (Asche, 2011, pp. 7-16). This means that the fish has undergone organic changes and can now filter saltwater through their gills and kidneys. As a result, they have now adapted to life in seawater. This process happens about 16 months after the fish hatched and are usually targeted around the month of May.

When to move the smolt from land to sea is a very important aspect. If you do it to soon many fish will die. But if you do it to late you will lose efficiency. The fish themselves signal when the time is right. When they swim with the current in the land-based facilities they are ready. (Asche, 2011, pp. 7-16)

2.3.4 Growth Conditions

Salmon has multiple different growth conditions. The most important being water temperature, reliable currents, good feed and sunlight. As stated above salmon is one of the species that has the highest degree of industrialization. But not all the growth conditions are easily affectable.

Water Temperatur, Sunlight and Currents

Salmon is a cold-blooded animal which means that the water temperature is important for the growth rate of the salmon (Mowi ASA, 2019). The ideal water temperature is between 8 and 14 degree Celsius. Salmon grows faster in Chile than in Norway because of a more stable water temperature. (Mowi ASA, 2019, p. 49)

Sunlight is also an important growth factor for salmon. In Norway this varies greatly based on which time of the year it is and where in Norway you are. Which indicates that the growth conditions inside Norway might vary. Today they use artificial lights to solve this issue (Asche, 2011, p. 12)

Currents are also an important growth factor. They need to be strong, but not too strong. Both to change the water in the nets so that the water quality is good, but also because the salmon swims towards the current in order to build muscle. These are all factors that are difficult to affect and are one of the reasons to why Norway is such an attractive country to produce salmon in. (Asche, 2011, p. 75)

Feed

The cost of feeding is around 50 % of the total cost per kilo. Over 70 % of the fish feed is plant matter with the rest coming from fishmeal and fish oil. (Seafood Norway, 2017, p. 31). The fish feed comes in the form of pellets. Feed is not only important when it comes to the cost in the industry. It is also very important for the growth rate of the fish. It is important to feed the correct amount. If you feed to much it will case waste and high costs and if you feed to little the fish will not grow to the desired size.

2.3.5 Environmental Conditions

In addition to being one of the most cost-efficient methods of animal product it is also one of the most efficient in terms of environmental pollution. Salmon is one of the most efficient feed converters for animal production. You only need 1,2 kg of feed to produce 1 kg of salmon meat. Compared to pork and cattle who need 3 kg and 8 kg of feed to grow one kg. (Seafood Norway, 2017, p. 31). The stocking density in the pens is only at 3 %, which means that 97 % of the volume in the pens is water. The salmon can roam freely in this space. (Seafood Norway, 2017, p. 41). To avoid cross disease between different generations they use a fallowing period of 2 months. Which means that the pens are empty for 2 months before new smolts can be released in the sea.

2.3.6 Loss of Fish

There are two factors that affect the loss of fish during the farming process. The first one is mortality and second is escaped fish. For mortality we divided between when the eggs have just hatched and when the fish are moved from freshwater to seawater. When the fish has just hatched, they have a survival rate of about 70 %. When the fish has been transferred to pens in seawater the average mortality rate are currently at around 20 %. As stated above salmon lice has been a big problem for the industry the last few years. The increased density of salmon lice has increased the mortality rate.

Most of the issues related to escapes comes from human failure in the production process. In Norway every single escape has to be registered and accounted for. The amount of fish escaped is irrelevant. By doing this they have control over the possible environmental affection the industry has on the local environment. (Fiskeridirektoratet, 2019a)

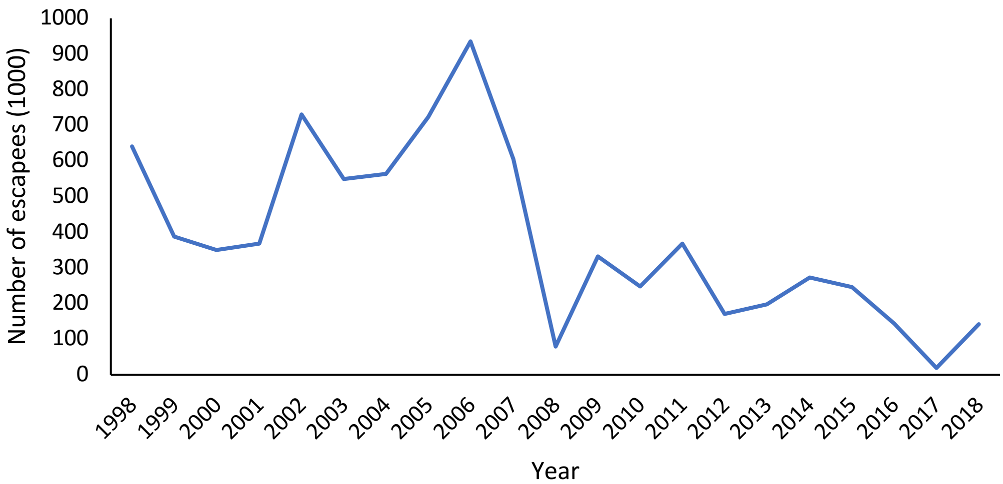

Figure 6 - Historical Development of Escapees (numbers in 1000) (Fiskeridirektoratet, 2019b)

2.3.7 Harvesting and Slaughtering

After about 24 months in the pen the salmon has grown to about 5-6 kg and are ready to be harvested. (Asche, 2011, pp. 7-16) There is a trade-off between the size of the salmon and the time it has spent in the sea pen. You want to harvest it when it has reached a certain size as the price you can get is higher for bigger salmon, but you also want to harvest as early as possible.

2.4 Regulation of the Industry

2.4.1 Farming Permits

Aquaculture is a permit-based industry. Before an aquaculture farm can start operating, they need to obtain a permit issued by the Norwegian government. (Directorate of fisheries, 2017) The permits regulate where you can farm salmon and how much production activity you can have in the corresponding area. It is also specified different criteria's you need to fulfil in order to operate. The list includes regulation regarding water quality, density of fish in the pens, environmental regulations, legal regulations, hygiene, monitoring, and feed regulations. (Akvakulturloven, 2005). Previously the government has issued salmon farming licenses. This terminology has now changed with the term permit or permission replacing license. (Arnason & Bjørndal, 2020, p. 11)

How the permits have been distributed has changed over time. In 2002 the government bodies were authorized to start charging for awarding operation permits. Before 2002 they were awarded free of charge. (NOU 2019:18, 2019, pp. 45-46) This reflected a political desire to develop a new industry which had significant risk and uncertainty connected to it. In 2018 they were distributed through a mix of fixed fees and auctions. The government has decided that this is the best method to ensure transparency in the allocation of the permits. (NOU 2019:18, 2019, pp. 45-46).

They estimate that about 80% of all the permits to perform salmon farming have been awarded free of charge. 17% has been awarded with a fixed fee and 3% have been sold at market price through an auction. The government states that the permits are worth over 200 billion, but the companies have only paid 6,8 billion NOK to obtain them. (Greaker & Lindholt, 2019)

2.4.2 Production Area Regulations

In the last few years the Norwegian government has introduced new environmental restrictions on the Norwegian aquaculture industry. In 2017 they introduced the Production Area Regulation. The new regulation is a system that gives an indication about the sustainability of the level of production in the different farming places. The sustainability is measured by the amount of salmon lice in the production area (NOU 2019:18, 2019, p. 64). The production area regulation is are given by a traffic light. Red means that you must decrease production as it is probable that more than 30 % of the biomass dies due to lice. Yellow means that you can keep the production at the level you have today but not increase. It is probable that 10 – 30 % of the biomass dies due to lice infection. And lastly, green means that you can increase the production level. It is probable that less than 10 % of the biomass dies due to lice infection (Pettersen & Hamarsland, 2018, p. 24). They have divided the country into 13 production areas. As of March 2020, production area 4 and 5 are classified as red and will be forced to reduce production.

Each permit has a maximum allowed biomass (MAB). In area 1-9 the MAB is 780 000 kg and in area 10-13 the maximum allowed is 945 000 kg (Directorate of fisheries, 2017). In the green production areas, the production can be increased a maximum of 6 % each year. 2 % is issued at a fixed fee of 120 000 NOK per ton. (Forskrift om kapasitetsøkning for tillatelser til akvakultur med matfisk i sjø av laks, 2017). Meaning that one standard permit of 780 000 kg is worth 93,6 million NOK. (Arnason & Bjørndal, 2020, p. 13) The remaining 4 % of production capacity is auctioned off. If you operate within area that is classified as red you must decrease production with 6 % (Directorate of fisheries, 2017). In Figure 7 you can see the defined production areas and their current status as of March 2020.

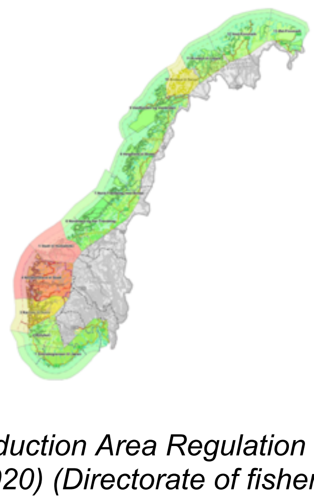

Figure 7 – The New Production Area Regulation and Their Current Status (March 2020) (Directorate of fisheries, 2020)

3. Taxation in the Norwegian Aquaculture Industry

In this chapter I will go through the taxation in the Norwegian aquaculture industry. As explained earlier, the salmon farming industry has changed drastically from the start in 1970. As the industry has grown, so has the regulations on the industry evolved. In this chapter I will present how the aquaculture industry is taxed today. I will also look into the topic of neutral and distortionary taxes as well as give an introduction to what a resource rent is and why it is relevant for the Norwegian aquaculture industry. After that, the majority and minority proposal from the tax commissions will be presented and lastly the proposal from the Ministry of Finance will be described.

3.1 Current Taxation of the Aquaculture Industry

This section will provide information about the current taxation model that is used in the Norwegian aquaculture industry. The information is based on the regulations as of 2019. The aquaculture industry mostly follows the usual taxation regulations in Norway. They are subjected to a corporate income tax rate of 22 % (Finansdepartementet, 2019). Aquaculture companies is also targeted for property tax by the municipality they operate in. The base to calculate the property tax is the value of floating aquaculture facilities in the sea. The assets needed to run a successful aquaculture business is often of considerable price. (NOU 2019:18, 2019, pp. 54-55). The Norwegian aquaculture companies are subjected to an export tax. The export tax consists of two different taxes called market tax and research tax. The market tax is supposed to fund the Norwegian Seafood Council and the research tax is supposed to fund Norwegian Seafood and Research Fund. The export tax is based on the revenue from export and is set at 0,6 % of the revenue generated by export. (NOU 2019:18, 2019, pp. 56-57)

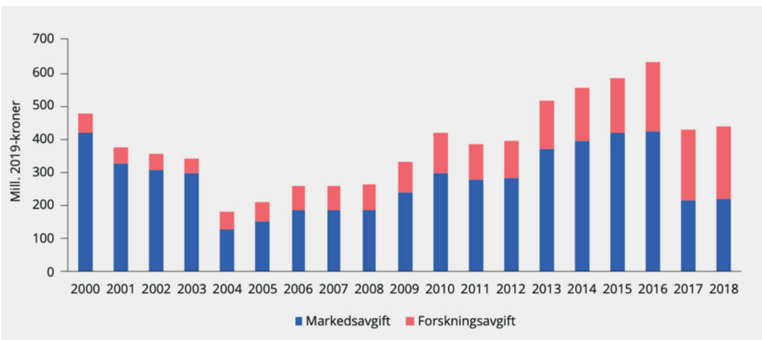

Figure 8 – Development of the Market Tax (Blue) and Research Tax (Red) (NOU 2019:18, 2019, p. 56)

The owners of aquaculture companies can also be targeted by wealth tax and divided tax. Individuals are targeted by a wealth tax of 0,85 % of their net wealth. (NOU 2019:18, 2019, p. 58) Tax on share dividend is calculated by a special method called “shareholder model”. The taxable dividend is adjusted upwards by a factor of 1,44 before they use the same rate as the corporate income tax. Meaning that the rate will be just below 32 %. (Altinn, 2019)

As explained in the previous chapter the Norwegian government also charges for the issuing of the permits to operate. The permits are issued by a mixture of fixed fees and auctions. (NOU 2019:18, 2019, p. 58)

3.2 Government Subsidies

The aquaculture companies are subjected to a differentiated employer’s national insurance contribution. The contributions are paid by the companies as a share of the worker’s salary. The rate is different from which geographical locations within Norway the companies operate. The rate is lower in the coastal area where the aquaculture companies are operating and therefore, they pay less than the companies that operate in more populated areas. As a result they are subsidised 300 million NOK from the government (NOU 2019:18, 2019, pp. 62-63)

In 2018 the industry was granted 200 million NOK in research funds from The Research Council of Norway. (NOU 2019:18, 2019, pp. 62-63). They fund research and innovation on all things related to aquaculture.

In addition, the Norwegian government are issuing development and research permits free of charge. These permits can be converted into commercial permits after the project is done at a price of 10 million NOK per permit. They do this to encourage innovation and development within the industry. If you take the auction price for 2018 into consideration the government has issued permits worth 10,5 billion NOK. (NOU 2019:18, 2019, pp. 62-63)

3.3 Evaluation of the Current Taxation System

In 2018 the Norwegian government appointed a special commission to investigate potential reforms for the taxation system in the Norwegian aquaculture industry. The Norwegian government has suggested that the super profits in the aquaculture industry may be caused by limited access to fish farming areas. The return on capital in the aquaculture industry was from

2008 to 2016 17,3 %, while the average return for other industries were 6 %. (NOU 2019:18, 2019, p. 22)

The commissions mandate was to investigate how the taxation system should be structured in order for the public to get their share of the resource rent. The taxation system should be structured in a way that makes sure that the companies still has incentives to make profitable investments. The commission should only look into the production of salmon, trout and rainbow trout in the sea, which means that land-based farming is not included in the proposal. (NOU 2019:18, 2019, p. 24). Before I investigate the commission's proposal, I find it necessary to describe the difference between a neutral and distortionary tax and describe what a resource rent is and why it can be taxed.

3.3.1 Neutral and Distortionary Taxes

When discussing taxes and whether the introduction of a tax changes the business decisions of the companies, we differ between neutral and distortionary taxes. The public sector should aim to collect tax revenue in a manner that constitutes the least obstacle possible to ensure efficient use of the societies resources. When behaviour and business decisions changes by the imposition of a tax or for potential tax savings it is distortionary. Some taxes do not affect business behaviour and decisions. These are called neutral taxes and when a business is optimizing their activities a neutral tax will not the distort the business decisions they take.

There are many factors that come into play when considering if a tax is neutral or not. For the purpose of this thesis the goal is to investigate if the introduction of a resource rent tax or production tax changes the production cycle. A tax that is neutral does not affect rotation time, but a tax that is non-neutral changes the optimal rotation time. (Amacher, Ollikainen, & Koskela, 2009, p. 31).

If a tax fails to be neutral it will cause a change in the behaviour of the participants. The cost of collecting the tax can be called a tax wedge or a deadweight loss. The deadweight loss represents the social economic loss as a result of introducing a tax. In the figure below you can see how the two different taxes creates distortions. As you can see the production tax will create a distortion in the behaviour, while a resource rent tax will not necessarily do so.

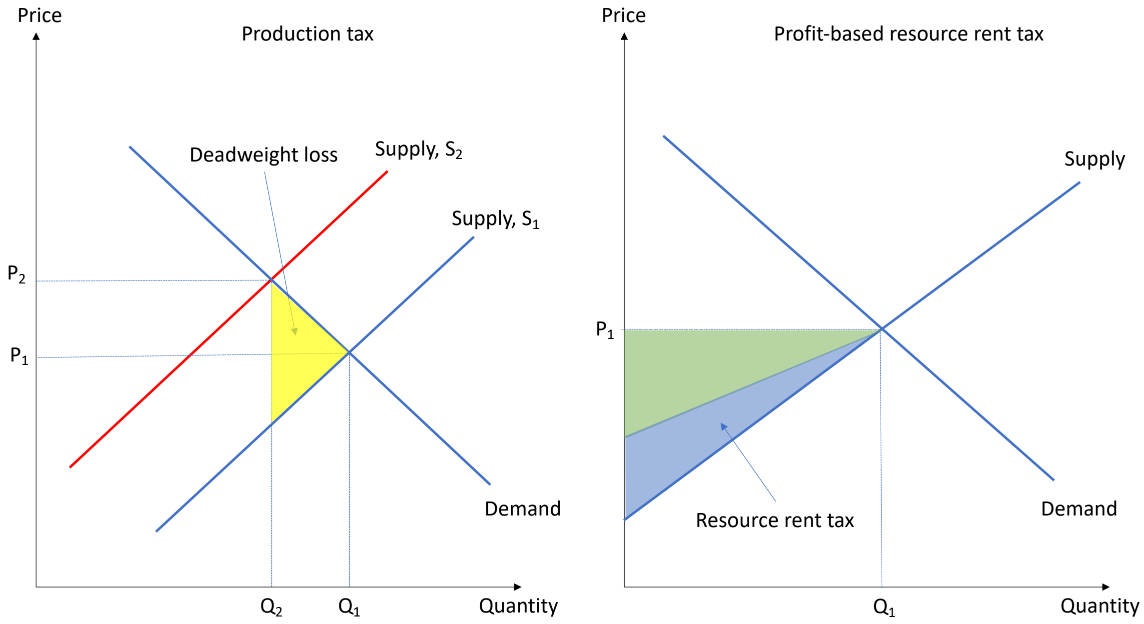

Figure 9 – Illustration of Deadweight Loss as a Result of introducing Production-based Tax and Profit-based Tax (NOU 2019:18, 2019, p. 99)

3.3.2 Resource Rent

Resource rent is generally described as extra ordinary profit deriving from utilization of a scare natural resources (KPMG Law, 2019, p. 19). Resource rent is to give an individual or a company access to a limited natural resource which result in higher return on invested capital. As a consequence, the company who has benefitted from the natural resource is asked to pay a resource rent.

Ricardo (1821) explains the definition of resource rent with an example of farmers establishing themselves in an unexploited land area. Picture a land area where no one is currently living. The first farmers who moves their will settle down at the areas with the best soil. After a while when they start to make money and the rumour about the newly discovered land spreads it will ensure that other people would start to move there. But the best land areas are already taken, and they will have to settle down at places that are not as good as the first areas. When even more people move there, they will have to settle further and further away from the best areas. The people with good areas will continue to make money and be profitable, but the others may struggle to make a living. The only difference being the land area and the quality of the soil. As a result, the soil is a fixed factor which yields resource rent. It is not the fact that the land areas are used in production that yields a resource rent, it is the difference in quality between the land areas, the fixed factor, that creates the resource rent. In a free market the last establishment, the marginal establishment, will not have a land area that yields resource rent. (Ricardo, 1821, pp. 39-50; Vennemo & Bjerkmann, 2018, pp. 9-10).

This example can be applied for the sea areas that the Norwegian aquaculture industry are using in their production. The combination of a limited resource because of the operation permits and the geographical structure of the coast areas ensures that in the last few years there might have been a resource rent in the industry. Hence, the resource rent in Norwegian aquaculture can be created by site-, production and permit (regulatory) rents. (Arnason & Bjørndal, 2020, pp. 15-16). In Norway, two industries already have resource rent in their taxation model. The oil industry and the hydropower industry. The oil industry they have a rate of 56 % and the hydro power has a resource rent tax at 37 %. (Finansdepartementet, 2019)

A common argument with taxation of economic rents is that they do not have an effect on production or the use of economic factors and is therefore economically neutral. But there are reports who suggest otherwise. Arnason (2010) is one who challenges this statement (Arnason, 2010). Arnason argues that the introduction of a tax on resource rent will have an impact on exit and entry, and composition of the companies within the industry. This may lead to bad secondary efficiency effects on the industry. Another problem with a resource rent tax according to Arnason is that it is not easy to observe and therefore you need empirical research to investigate the size of it. During these calculations there are many potential pitfalls where you can go wrong. Arnason also argues that because less funds are retained in the industry less investments will be made which will have a negative impact on the economic growth. Unless the government uses the fund in a more efficient matter than the private companies.

3.3.3 The Tax Commisions Proposal

Now that I have described resource rent and what characteristics a tax should have to whether it should be considered as neutral or not it is time to look into the tax commission’s proposal. In November 2019 the commission delivered their proposal for the new tax regime in the Norwegian aquaculture industry. The commission was split into two groups; the majority proposal and minority proposal where the majority consist of 6 of the members and the minority consist of 3 members. First, I will go through the majority proposal before I present the minority proposal. All the information below is collected from NOU 2019:18. (NOU 2019:18, 2019, pp. 139-185)

The Majority Proposal

The majority propose that the resource rent in Norwegian salmon aquaculture is captured through a profit-based resource rent tax. This will ensure that investments that are profitable before tax are also profitable after tax. By structuring it this way it will also accommodate profitability fluctuations in the industry.

The resource rent tax in aquaculture should capture the same share of the profit as in the hydropower industry. They have looked for guidance to hydropower tax regime when determining the rate of the resource rent tax. They suggest that in addition to the regular corporate income tax of 22 % they should also have a resource rent tax at 40 %. The resource rent tax should be calculated from a new tax base called resource rent income tax base.

The principle for determining the gross resource rent revenue will be based on the Nasdaq Salmon Index. This is different from the hydropower structure where they use the actual realized sell price as the reference point.

The deductibles in the tax base is cost that are relevant to production in the sea where the resource rent is created. The commission propose that all cost up until the point where the fish is harvested should be considered deductible. Smolt-, feed-, medicine-, vaccine-, labour- and harvest costs should all be included. Other operation costs and capex should also be considered deductible. Finance cost, loss on receivables, should not be included.

The majority propose that it should be a periodized tax regime which means that the tax deductibles from the investments will be spread out over time. As a result of the capital being locked, the commission will create a special tax deduction called uplift (friinntekt) which will be calculated based on the value of the assets needed to have production in the sea. The value of the permit shall not be included in the calculation of the uplift as the permits are assumed to last in perpetuity and will not drop in value over time.

The tax revenue should be divided between central government and municipalities through a distribution key. They will use the same distribution key as they do today through The Aquaculture Fund. The municipalities tax will be a production-based tax that is determined by how much biomass is in their specific area. The production tax is deductible from general income. Therefore, the tax paid to the municipalities works as a distribution mechanism between them and the central government. They do not specify the size of the production tax in their proposal.

Furthermore, the majority propose that property tax should be eliminated for all investments that goes into the production in the sea. In addition, they suggest that the export tax and market rent is abandoned.

Permits for salmon farming should be auctioned off as this is the most efficient and transparent method of distributing permits. Previously, the permits have been issued by a fixed fee, but this should be abandoned. The research permits should still be issued free of charge.

Reasoning Behind the Majority Proposal

In the previous section I presented the structure of the majority proposal. In this section I will look into why they have proposed this exact structure. The majority proposal states that; from the definition of resource rent there is no doubt that there is a resource rent that should be captured in the Norwegian aquaculture industry. The commission states that the aquaculture companies should pay for using public owned natural resources. As of today, the profit in the industry is going to a few people or investments groups as 50 % of the total production is owned by four companies. The companies are Mowi, Lerøy Seafood, Salmar and Cermaq. In addition, 35 % of the market value is owned by foreign investors. The resource rent tax will ensure that more of the generated profit will stay in Norway.

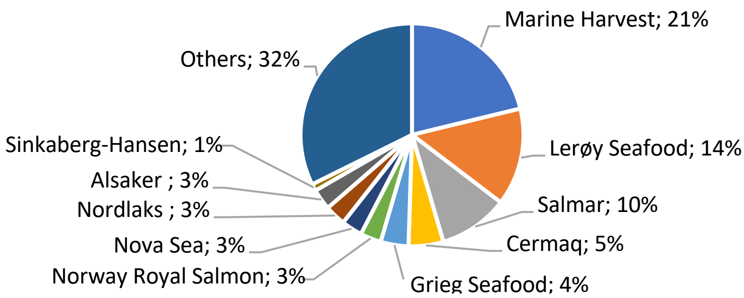

Figure 10 – Production Capacity in Percentage of the Total Production Capacity (NOU 2019:18, 2019, p. 35)

The commission has mainly discussed two structures to capture the resource rent. Either by a profit-based tax or by a production-based tax. The majority in the commission is in favour of introducing a profit-based resource rent taxation instead of a production-based taxation system. The main argument behind the decision is that investment decision that are profitable before tax will also be after tax when using a profit-based structure. While a production-based tax can make a profitable investment before tax not profitable after tax. Therefore, the commission argue that a profit-based will be neutral tax as it will not change the investment decisions of the companies. They use the same argument for abandoning market and research tax. They argue that both these are taxes based on production and are therefore not neutral by definition.

The commission also had to choose between using a cash flow system or a periodized system. The main difference being how the companies will receive their tax deductions on their investments. They propose a periodized model where the companies will get their tax deductibles spread out over time instead of getting the deductions directly in the year the investment is made, like they would in a cash flow system. As a consequence of the deductibles being spread out over time the companies will be compensated for the capital being locked in investments because of time value of money. The commission proposes that the uplift should be calculated using the average annual rate of 12-month government issued bonds. They argue that the payments are from the government and should therefore be considered as good as risk free (NOU 2019:18, 2019, pp. 155-156). The base for calculating the uplift is the tax value of the assets used for production in the sea. There is also a debate whether the cost of the permits is going to be included in the calculation of the uplift. The majority of the commission states that they propose that it is not included because the permit will not drop in value over time as an ordinary asset will do (NOU 2019:18, 2019, pp. 156-157).

The commission used multiple methods to determine that the resource rent should be set at 40 %. A common denominator for these methods is that they want to determine how much of the revenue the natural resource, in our case the fjords, generate. Since they have modelled the proposed tax regime on the hydropower plant taxation it was natural to seek guidance from that regime when determining the rate.

The commission estimates that a 40 % resource rent tax will generate revenues of about NOK 7 million to the government. But as the industry is cyclical this will vary from year to year. (NOU 2019:18, 2019)

The Minority Proposal

The minority in the commission propose that no resource rent should be introduced to the aquaculture industry in Norway. They are of the view that the existing structure with auction of permits is enough to capture the resource rent in the industry. Should the growth within the industry decrease, they suggest that a small production fee is introduced. Although they do not have a specific structure or rate/size of the tax. They are of the view that the existing distribution key between the central government and the municipalities should be continued. The minority propose that the property tax on fish farms in the sea is not abandoned. The minority suggest that the issue regarding the market tax and research tax should be evaluated in a separate and individual evaluation. (NOU 2019:18, 2019)

3.3.4 Proposal From the Ministry of Finance

As of 12 May 2020, the Ministry of Finance and Ministry of Trade, Industry and Fisheries proposes to not proceed with a profit-based resource rent tax and instead introduce a production tax of 0,4 NOK per kg produced salmon. The tax will be split between regional and local governments (Finansdepartementet, 2020). They have estimated that the tax will contribute to over 500 million NOK to the regional and local government. This proposal very much resembles the minority proposal of introducing a small production tax instead of a profit-based resource rent. In addition to the production tax the ministry of finance propose that the regional and local government should get 25 % of the revenue from production permits sold in their area. The other 75 % will go to central government. The changes will come to affect 1 of January 2021 and the tax payments are due in 2020 (Finansdepartementet, 2020).

3.4 Debate About the Resource Rent Tax

The commission's proposal about introducing a resource rent tax has not been popular with the salmon farming companies. As of now I have presented the tax commission's and Ministry of Finances proposal and their arguments in favour of introducing a resource rent tax. In this section, I will go through some of the arguments in favour of not introducing the resource rent tax. The arguments of not introducing the resource rent is collected from industry participants. This is important to understand how the companies might change their behaviour if the tax is introduced.

One of the main arguments against the proposal is that it will make Norwegian aquaculture less competitive on a global scale (Sjømat Norge, 2020). There are multiple countries that have the ability to produce salmon. Not many years ago Norwegian aquaculture had a market share of 65 % globally, but today that has dropped to 50 % (Berge, 2018). It can be argued that the tax could make the Norwegian aquaculture industry less competitive compared to other countries that produce salmon, which may lead to and decrease in the global market share. New emerging technology might change this even more. Many companies are working on building land-based facilities where they can farm salmon without the natural environment that the Norwegian coastline provides. (kyst.no, 2018)

A second argument is that the industry is cyclical and the super-profit that has been the last few years is not sustainable for the future. Which may indicate that the commissions estimations of 7 billion NOK in tax revenue might not be totally accurate (NRK, 2020) Another reason for the super-profit is that the Norwegian Krone is weak against other currencies. Which gives a positive effect for the companies that has their majority of their costs in NOK and revenue in other currencies. (Nyrud et al., 2016)

Norway is the only country in the world who has this proposal on the table (KPMG Law, 2019). The industry argues that this might be a problem if we look at the possible investments from foreign inventors. If international investors study the aquaculture industry and see that Norwegian Aquaculture has a 62% tax rate and all other countries have tax rates in the interval 12,5% to 30%, they might lose their interest in investing in Norway. (KPMG Law, 2019)

The big companies will look into either moving the farms abroad to different locations. Or maybe even look into other solutions as land-based facilities. As the proposal of introducing resource rent does not apply for land-based farming (NOU 2019:18, 2019, p. 13). The commissions argument against this is that new companies will look to get the abandoned permits to farm salmon in the fjords in Norway. Even with a resource rent tax salmon farming will be profitable and they will always be able to auction off production permits to existing or new players in the industry. An argument that the commission are using in favour of incorporating the new taxation model is that the profit from the aquaculture industry is going to people with a different nationality as 35% of the Norwegian salmon aquaculture is owned by foreigners. But it is also important to get foreign investments into the industry.

85 % of the aquaculture industry’s profit is generated in the last ten years where 46 % is generated in the last three year (2016-2018) (Sjømat Norge, 2020, p. 16). This might be an indication that the extra ordinary profit is a result in innovation in processes and technology that makes it easier to farm fish. Which in theory should not be the subject of a resource rent tax.

For the production tax the industry is somewhat unhappy by the size of the production tax as they were aiming for a tax of around 0,25-0,3 NOK per KG (Kyst.no, 2020). As the size of the production tax is much smaller than what the tax commissions proposed it has not been meet with the same resistance.

4. Theoretical Framework

In this chapter I will present the theoretical framework I will use to investigate the effects the introduction of taxes will have on the production cycles. To construct the bioeconomic model I will use theory based in the optimal rotation problem first presented in the 1850s by Martin Faustmann. In section 4.1 I will conduct a literature review. Next, in section 4.2 I will present the model. And lastly in section 4.3 I will address the extensions that are added to the model in order to investigate how the different proposals will affect the optimal rotation time.

4.1 Literature Review

All harvest models for aquaculture can be traced back to Faustmann's work on optimal forestry rotation. Faustmann's initial model on optimal forestry suggest that a tree should be cut down when the increase in marginal value of the three is equal to the alternative cost of capital in trees and land. When transforming the model from harvesting forestry to aquaculture some altercations have been made. As salmon and shrimp have been the most successful aquaculture species most attention have been given to these two species. Bjørndal (1988) developed the first optimal harvesting models for aquaculture based on Faustmann forestry literature. In his model he does not take the rotation problem into account. Therefore, he analysis a one-time investment in age-class of salmon. The model can be explained in a few steps. Fish are released in the sea into the sea at time period *t*. As time goes on some fish die at a constant mortality rate while the other fish grow according to a defined growth rate. The model assumes that the price of fish is constant hence the value of the fish can be expresses as the number of fish at time *t* multiplied with the weight of the individual fish at time *t* multiplied with the price of the fish at time *t*. The optimal time to harvest the fish will be when the marginal value of the fish is equal to the return elsewhere in the economy.

Since Bjørndals model was introduced, several authors have extended the model to evolve specific aspects of the model. Including Arnason (1992) who introduced dynamic behaviour in terms of feeding schedule and presented a general comparative analysis. Heaps (1993, 1995) introduced density dependent and independent growth. While Mistiaen and Strand (1998) demonstrated solutions for optimal feeding and harvesting times with weight-dependent prices. And lastly, Guttormsen (2008) focused on restricted smolt release and different relative prices between weight classes. (Asche, 2011, p. 184) The bioeconomic model created by

Bjørndal (1988) suggest that one should harvest the biomass when the proportional increase in the biomass is equal to the interest rate.

When investigating if there has been conducted any research on incorporating taxes in the bioeconomic models created for aquaculture I have not found any academic literature. In order to find literature on the topic I had to go back to literature on optimal forestry taxation. Koskela and Ollikainen (2000) discuss three different taxes that can be incorporated into the forestry models. The taxes are proposed as either a yield or unit tax on harvest, property tax, or profit tax.

4.2 The Optimal Rotation Problem

As fish farming is becoming more competitive and industrialized optimal planning processes become a key factor in profitability. This is called optimal rotation, which means finding the best sequence of release and harvesting (A. G. Guttormsen, 2008). The bioeconomic model that will be used in this thesis is presented in Asche and Bjørndal (2011). The model determines the optimal harvest time for the farmed salmon. The only cost that is relevant for the decision making is variable cost as all plant investments are assumed to be sunk cost and therefore irrelevant to the decision process. (Asche, 2011, pp. 163-184).

4.2.1 Number of Fish

When smolts are released into pens we call this a year class. In this model we assume that there is only one release hence all the fish in the pens are the same age. This implies that the number of fish in a pen will never grow larger than the number released. As the fish lives in the pens we assume that they have a constant mortality rate. The number of fish released in year 0 is called Recruits and are often expressed as R. The number of fish at a given time *t* can mathematically be expressed as:

$$N(t) = Re^{-M(t)} \quad (1)$$

4.2.2 Weight per Fish

The weight per fish at time *t* is expressed as $w(t)$. The change over time, hence the growth, is expressed as:

$$w'(t) = g[w(t), N(t), F(t)] \quad (2)$$

Where $w'(t)$, the growth, is a function of the three variables weight, number of fish and feed quantity. $w(t)$ is the weight, $N(t)$ is the number of fish in the age class and $F(t)$ is feed quantity. These variables are assumed to be a function of time.

In this model we assume that all fish are the same weight when they are released into the pens and that they grow at the same rate. The growth function can be extended by including other factors such as temperature and daylight etc. The individual fish will grow towards $w'(t) = 0$ when the weight of the individual fish is at its maximum.

4.2.3 Total Biomass

Total biomass is a function of the number of fish, $N(t)$ and weight of the average fish, $w(t)$. Total biomass at time *t* can be formulated as:

$$B(t) = N(t)w(t) = Re^{-M(t)}w(t) \quad (3)$$

This implies that all the individuals in the pen is the same weight. This do not represent reality as the fish are different size when they are moved from freshwater to seawater and they have different growth rate. But in order to simplify our calculations we look at the average individual and assume that they are the same weight. As time goes on some fish will grow and some will die with a constant mortality rate. We can formulate the change in biomass at time *t*:

$$B'(t) = \left[\frac{w'(t)}{w(t)} - M\right] B(t) \quad (4)$$

Where the first term in the brackets is the relative growth rate at time *t* minus the mortality. In the start it is assumed that the relative growth rate is higher than the mortality rate, so the biomass can increase over time. When the relative growth rate is equal to the mortality rate the biomass is at its maximum. The total biomass will reach its maximum before the individual fish because the trade-off between the growth rate and the mortality rate.

4.2.4 Value of Total Biomass

The model is developed as a zero-cost model. Initially, we do not take costs into consideration. The value of the total biomass can be expressed as price times biomass. Which gives us the expression:

$$V(t) = p\big(w(t)\big)B(t) = p\big(w(t)\big)Re^{-M(t)}w(t) \quad (5)$$

Where $p\big(w(t)\big)$ is the price per kilo fish. As weight $w(t)$ is a function of the age of the fish, *t*, price is also a function of time. The price normally varies based on the size of the fish. Where bigger price can be charged if the fish is larger. The time when biomass reaches its maximum value is given by $V'(t) = 0$. The number of recruits and the growth are assumed to be exogenous variables. Growth of the value can be expressed as:

$$V'(t) = \left\{\frac{p'(w)}{p(w)}w'(t) - M + \frac{w'(t)}{w(t)}\right\}V(t) \quad (6)$$

Where the first term in the bracket represents the change in price as a result of growth, the second represents mortality rate and the third the growth rate.

4.2.5 Optimal Rotation Time

When calculating the optimal rotation time, the model assumes infinite amount of rotations. Optimal rotation length is the present value of all future rotations. In order to calculate this number, we introduce a discount term. The optimal discounted profit at time *t*, the optimal rotations, is given by this formula:

$$\pi(t) = \frac{V(t)}{e^{rt} - 1} \quad (7)$$

Where *t* is the rotation time. The first order condition of the profit function is given by:

$$\pi'(t) = \frac{V'(t)\,(e^{rt} - 1) - re^{rt} - V(t)}{(e^{rt} - 1)^2} = 0 \quad (8)$$

And by and simplifying this expression we can derive:

$$\frac{V'(t^*)}{V(t^*)} = \frac{r}{1 - e^{rt^*}} \quad (9)$$

The term t^* is now to be defined as the optimal rotation time. Rewriting the expression so the left side represent the change in biomass. It shows that the last term is the present value of future profits.

$$V'(t^*) = rV(t^*) + r\frac{V(t^*)}{e^{rt^*} - 1} \quad (10)$$

Optimal harvest is given by the point where the marginal effect of the fish stock is equal to the opportunity cost elsewhere in the economy.

$$V(t^*) = \left\{\frac{p'(w)}{p(w)}w'(t^*) - M + \frac{w'(t^*)}{w(t^*)}\right\}V(t^*) = rV(t^*) + r + \frac{V(t^*)}{e^{rt^*} - 1} \quad (11)$$

Which can be rewritten to:

$$V(t^*) = \left\{\frac{p'(w)}{p(w)}w'(t^*) + \frac{w'(t^*)}{w(t^*)}\right\} = r + M + \frac{r}{e^{rt^*} - 1} \quad (12)$$

This expression shows that optimal harvest is given by the marginal revenue of keeping the fish in the sea is equal to the marginal costs.

4.2.6 Harvest- and Production Cost

Harvest and production cost are calculated based on the total biomass that is produced. When costs are introduced to the model it takes the form of a cost per kilo of biomass. If we harvest at time *t* the total harvest and production cost can be expressed as $C_pB(t)$. Where C_p captures the harvest and production cost. We now assume that the price minus the production cost is the net price per kilogram the farmer receives when harvesting. We can therefore modify the value of the biomass to:

$$V(t) = \{(p(w(t)) - C_p\}B(t) \quad (13)$$

In order to calculate the optimal profit, we need to incorporate this new value expression into the profit function:

$$\pi(t) = \frac{\{p(w(t)) - C_p\}B(t)}{e^{rt} - 1} \quad (14)$$

And the optimal harvest is then expressed as:

$$V(t^*) = \left\{\frac{p'(w)}{p(w) - C_p} w'(t^*) + \frac{w'(t^*)}{w(t^*)}\right\} = r + M + \frac{r}{e^{rt^*} - 1} \quad (15)$$

This indicates that if r or M changes so will the optimal rotation time change. An increase in r or M will cause a decrease in the optimal rotation time. While a decrease in one of the variables causes an increase in the optimal rotation time.

4.3 Extentions to the Model

4.3.1 Introducing Taxes

The model presented in Asche and Bjørndal (2011) do not take taxes into consideration. In order to incorporate taxes in the model I will look elsewhere for literature on the topic. In the analysis two different tax proposals will be investigated. The first proposal suggested a profit-based resource rent tax and the second proposal is a production tax based on the biomass produced. But first I will introduce an ordinary profit-based corporate income tax before the two proposals is introduced.

Corporate Income Tax

When introducing taxes, the profit function must be altered. Koskela and Ollikanien (2000) suggests that a profit-based tax in a Faustman model will not change the optimal rotation time. It only represent a loss of net harvest revenue functioning as a neutral tax (Koskela & Ollikainen, 2000, p. 4). If a proportional tax t_p is used, the net harvest revenue in the absence of other taxes can be expressed as:

$$\pi(t) = (1 - t_p)\frac{V(t)}{e^{rt} - 1} = (1 - t_p)\frac{\{p(w(t)) - C_p\}B(t)}{e^{rt} - 1} \quad (16)$$

As expression (17) shows the profit tax will not create a distortion in the optimal rotation time. The optimal harvest is then expressed as:

$$(1 - t_p)V(t^*) = (1 - t_p)\left\{\frac{p'(w)}{p(w) - C_p} w'(t^*) + \frac{w'(t^*)}{w(t^*)}\right\}$$
$$= (1 - t_p)\left(r + M + \frac{r}{e^{rt^*} - 1}\right) \quad (17)$$

Resouce Rent Tax

The Resource rent tax is calculated from a different tax base that the corporate income tax base. As a result, I need to calculate a different tax base for the resource rent. The tax base will have a different $V(t)$ function. I therefore define $V_1(t)$ as the corporate income tax base and $V_2(t)$ as the resource rent tax base. The difference being the input of deductibles in the tax base. In order to differ the deductibles in the resource rent tax base from the harvest and production cost, C_p, I create the variable C_r which will be the deductibles in the resource rent tax base. In addition, an uplift F is created. The tax rate in the resource rent tax base is denoted as t_r. The optimal profit can be found by subtracting the resource rent tax from the $V_1(t)$ function. Therefore, the profit function can be formulated as:

$$\pi(t) = \frac{(1-t_p)V_1(t)}{e^{rt}-1} - \frac{V_2(t)t_r}{e^{rt}-1} \quad (18)$$

$$\pi(t) = \frac{(1-t_p)\{p(w(t)) - C_p\}B(t)}{e^{rt}-1} - \frac{(\{p(w(t)) - C_r\}B(t) - F)t_r}{e^{rt}-1} \quad (19)$$

Which changes the optimal harvest to:

$$\begin{aligned}
&(1-t_p)V_1(t^*) - V_2(t^*)t_r \\
&\quad = (1-t_p)\left\{\frac{p'(w)}{p(w)-C_p}w'(t^*) + \frac{w'(t^*)}{w(t^*)}\right\} \\
&\quad - \left\{\frac{p'(w)}{p(w)-C_r-F}w'(t^*) + \frac{w'(t^*)}{w(t^*)}\right\}t_r \\
&\quad = (1-t_p)\left(r + M + \frac{r}{e^{rt^*}-1}\right) - \left(r + M + \frac{r}{e^{rt^*}-1}\right)t_r \quad (20)
\end{aligned}$$

Production Tax

Production tax is Faustmann's model is discussed in Amacher et.al (2009) where they talk about the effect of introducing a yield or a unit tax on harvest. They state that the introducing of a yield or unit tax on harvest will lengthen the rotation time as the opportunity cost of continuing a rotation is reduced if the tax is introduced. (Amacher et al., 2009, p. 31) The proposal of introducing a production tax will come in addition to the ordinary corporate income tax the Norwegian aquaculture industry already is subjected to. The production tax will be determined by the production of salmon measured in kg. Originally, Amacher et.al (2009) propose to express the yield and unit tax as a decrease in the net price. $\hat{p} = p(1-\tau) -$

u . But with the introduction of a corporate income tax I find it necessary to separate the calculation of the production tax because otherwise the production tax will be considered as a deductible from the corporate income tax base. The production tax can therefore be subtracted from the $V(t)$ and the unit tax can be expressed as $B(t)u$. The profit function can now be rewritten as:

$$\pi(t) = \frac{(1 - t_p)\left(\{p(w(t)) - C_p\}B(t)\right) - B(t)u}{e^{rt} - 1} \quad (21)$$

The optimal harvest can now be expressed as:

$$(1 - t_p)V(t^*) = (1 - t_p)\left\{\frac{p'(w)}{p(w) - C_p}w'(t^*) + \frac{w'(t^*)}{w(t^*)}\right\} - B'(t^*)u$$
$$= (1 - t_p)\left(r + M + \frac{r}{e^{rt^*} - 1}\right) (22)$$

4.3.2 Capacity Constraints

The model does not take capacity constraints into consideration. The introduction of the capacity constraint was first introduced by Pettersen and Hamarsland (2019) in their thesis about the economic effects of the production area regulation (Pettersen & Hamarsland, 2018, p. 32). The Norwegian government has newly introduced the production area regulation which gives a maximum allowed biomass constraint (MAB). If the optimal biomass for one permit is larger than the MAB it will most certainly affect the optimal rotation length because they would have to harvest before the biomass has reached its maximum potential. The model assumes that harvest is done when the marginal revenue is equal to the marginal cost The MAB constraint can be expressed as:

$$B(t) \leq MAB \quad (23)$$

5. Research Methodology

In this chapter I will present the research methodology that are used to conduct the necessary analysis to answer the defined research question. The overall goal of this chapter is to show which methods that are used and discuss the strength and weaknesses of this method. This is important because the results obtained from the analysis is based on the research methods it is built on. The literature is collected from Saunders et.al (2009) unless other is specified. (Saunders, Lewis, & Thornhill, 2009).

5.1 Research Design

The research design is the overall proposal of how the research of this thesis will be conducted. Research design is further dived into research approach, research method and research strategy. In the next sections the research design used in this thesis will be described.

5.1.1 Research Approch

The research approach for a project should be determined by the thing you want to research. The goal in this thesis was to investigate the different tax proposals from the tax commission and the Ministry of Finance and see how the proposals affect the optimal rotation time if they are introduced. As a result, the research has a mixture of exploratory and descriptive nature. As there are many different economic theories regarding the topics, meaning resource rent, neutral taxes and bioeconomic models, the research will resemble a deductive research approach. A deductive research approach is when the research is based on existing economic literature and you use the literature as the base of your analysis. In my thesis I will use the bioeconomic model presented in Chapter 4 to determine if the taxes change the optimal rotation time. The model is quite specific with the parameters that are needed in the model. The data used as input in the model and how it is collected will be described in section 5.2. I have now established that I will use a deductive research approach and that I need to collect numerical data to use as input in the bioeconomic model. As a result, I can move on with a quantitative research method.

5.1.2 Quantitative Research

In order to determine if the optimal rotation time will change with the introduction of the tax it was decided that the best research method to answer this question was quantitively research methods. Ragab and Arisha (2018) describes quantitative methods as methods that investigate phenomena through the collection of quantifiable data in numerical form and apply mathematical models and statistical techniques for data analysis (Ragab & Arisha, 2018, p. 7). The analysis is structured as an experimental research where I add and change different factors in the bioeconomic model in order to see what happens with the rotation time when maximizing the profit. The factors that will be added are the two tax proposals. When the initial bioeconomic model is setup with the structure of the tax included there will also be investigated how changes in the different rates and sizes of factors will change the rotation time within the proposed tax structures.

The price function is estimated by a regression analysis in Stata 16 and the two bioeconomic models is created and analysed in Microsoft Excel 2016. In order to find the optimal rotation time, I created a model that assumes that maximum profit for an infinite number of rotations is a function of rotation time. In order to find the rotation time that creates the optimal profit I used the solver within Microsoft Excel. By changing the rotation time all the factors that are a function of time will change and as a result the optimal profit will also change. As the analysis covers two different proposals of how the tax should be structured two bioeconomic models was created.

5.1.3 Research Strategy

The research strategy is the strategy used to collect the necessary data. There are many different quantitively research strategies. Examples can be survey, experiments, case study etc. The data collected in this thesis can be described as secondary data. Secondary data is data that already exist in published material. This differs from primary data which is data collected by the researcher to answer his specific research question. As the data is not collected by me and the fact that the data is not collected to answer my specific research question it is important to describe and give an evaluation of how it has been collected. This will be described in section 5.2 and later an evaluation of the reliability and validity will be given in section 5.3.

5.2 Research Data

In this section I will present the data that is collected in order to answer the research question. The two main sources of information used are the Directorate of Fisheries and Nasdaq Salmon Index. Both the data from the Directorate of Fisheries and the Nasdaq Salmon Index will be used as input in the bioeconomic model, but the data from Nasdaq Salmon Index will specifically be used to estimate a price function where price is a function of weight. I have also used data from Pettersen and Hamarsland (2018) and their data source is the Directorate of Fisheries presented to them under a research permit (Pettersen & Hamarsland, 2018, p. 35).

The data from both the Directorate of Fisheries and Nasdaq Salmon Index can be categorized as panel data as the data collected is for the same participants over multiple time periods. The time period is from 2008 to 2018 for the data from the Directorate of fisheries and from 2013 to 2018 for the Nasdaq Salmon Index.

5.2.1 Directorate of Fisheries

In order to find parameters needed in the bioeconomic model I will use data that is publicly available from the Directorate of Fisheries. The data can be described as complied data set meaning that the data has been processed before it was published. This differs from raw data which is data that is untouched and unprocessed by anybody before you. It can be defined as a panel data set with yearly economic figures. The data is given in the time period between 2008 and 2018. In 2018 they collected data from 88 % of the active permits which means that the data is good representation of the total active permits. The Directorate of Fisheries do not specify which production area each permit belong to. Which means that there is uncertainty regarding if all the production areas are represented in the selection. The data from the Directorate of fisheries is reported in different levels. Meaning that some data are given at company level and some are given on permit level. The bioeconomic model that will be created based on the theoretical framework represents the operation of one permit which means that some of the data must be altered to a permit level before it can be used as input in the bioeconomic model. Some of the data must be generalized into cost per kg.

The data collected from the Directory of fisheries are assumed reliable as the Directorate is an independent organization from the companies in the industry and would not gain anything from reporting wrong numbers. The Directorate of Fisheries is a subordinate agency under the ministry of Trade, Industry and Fisheries. It serves as the Ministry's' advisory and executive body in matters of pertaining to fishing and management to aquaculture (Ministry of Trade, 2020) In 2015 the Agency for Public Management and eGovernment analysed the performance of the Directorate of fisheries. They concluded that the Directorate is assumed to be a professionally and solid entity that in general delivers good results (Direktoratet for forvaltning og IKT, 2015). The directorate have information about the industry that dates back to 1982. Fish farming companies that operates within Norway are obliged to report monthly status per pen and per fish farming location. They must also report feed usage, loss of fish amongst other things (Akvakulturloven, 2005). One weakness in the data published by the Directorate is that it is based on the information the companies report to them. Some companies report their financial result based on concern level and some at region level. The data I will retrieve from the directorate includes number of recruits, mortality rate, value of assets used in aquaculture, harvest- and production costs.

In their report about the production area regulation Pettersen and Hamarsland (2018) created a growth function and price function in order to research the economic effects of the new regulation. As a part of their research they received a research permit from the Directorate of Fisheries and calculated how different factors changed in the 13 production areas. As I do not intend to research how the tax affect specific production areas, I will use the average of their results over the different production areas.

Table 3 - Overview of the Most Important Variables Collected from the Directorate of fisheries

Directorate of fisheries		
Mortality rate	Number of deceased fish	%
Harvest cost	Cost of harvesting 1 kg of salmon	NOK/KG
Production cost	Cost of producing 1 kg of salmon	NOK/KG
Production area constraint	Maximum allowed biomass at one pen	KG
Tax value of assets	Value of assets needed to operate one permit	NOK

As the data collected is secondary data and originates from a data set that only reports economic figures, I do not have access to any detailed descriptive statistics.

5.2.2 Nasdaq Salmon Index

In this part of the thesis I will introduce the data that is used to estimate the price function. I will use historic data collected from the Nasdaq Salmon Index. (Nasdaq, 2019) The index has weekly data updates about the price per kilo salmon from 1998 to 2020. The index is the weighted average of weekly reported sales prices and corresponding volumes in fresh Atlantic Salmon, head on gutted (HOG). The panel is representative for the total export out of Norway. (Nasdaq, 2019). The data can be described as a complied data set because it has been processed before it was published.

In the data from the Nasdaq Salmon Index the data is sorted with price given a certain weight in addition to the year and week it is sold in. In order to get a more accurate price function, I will add a categorical variable for the month in order to take fixed effects into consideration. Fixed effects of the categorical variable year will also be taken into consideration. The data set collected has 3267 observation in the time period between 2013-2020.

Table 4 - Overview of the Variables Collected from the Nasdaq Salmon Index to be Used to Estimate Price Function

Nasdaq Salmon Index		
Price	Price given weight	NOK
Weight	Weight of the sold fish	KG
Month	Month	Categorical
Year	Year	Categorical

The data set collected is secondary data. The data set does not report any detailed descriptive statistics based on the data.

5.2.3 Uncertanity in the Data

As stated above the economic figures I have used in my calculations are presented at different levels. Some of the information used the average on company level and some at permit level. If one were to change this figure from permit level to company level, there might be some distortions. That said, it will not be a decisive problem for the purpose of my calculations.

The Directorate of Fisheries do not use information from every company within the industry. They use a selection of the total population. On a permit level the selection for 2018 is good at 88 % but the average over the time period between 2008 and 2018 is 68,5 % with the lowest being in 2002 at 63,6 % of the total active permits (Directorate of Fisheries, 2020). The sample of the total population is assumed to be a good representation of the total population but there might be some minor distortions due to the fact that not every permit is included in the data.

As stated above the companies are required to report data about the biomass to the Directorate on a monthly basis. But as it is very difficult to measure the amount of biomass that are in a pen at any given time the numbers reported are estimates from the companies.

As the data from the Nasdaq Salmon Index is given in intervals ranging in 1 kg the data will not be totally accurate. A simplification I did in the analysis was that I assumed that the salmon sold in the interval 1-2 was 1 kg, the salmon sold in the interval 2-3 was 2 kg etc. But as I do not have information about the distribution in the specific intervals it is a fair assumption. The Index is based on sales for HOG salmon. Not all export is sold as HOG, but it still gives a good estimation about the price.

Both the Directorate of Fisheries and the Nasdaq Salmon Index are independent organizations that do not have any incentive to give false and incorrect information.

5.3 Evaluation of the Research

As the data that are collected and used as input in the bioeconomic model is secondary data I do not have control over the collection of the data. As a result, it is very important to evaluate the quality of the data collection. In an evaluation of the research we usually use the terms reliability and validity. Under both these terms I will first evaluate how the data has been collected and then evaluate how I have collected data.

5.3.1 Reliability

When it comes to the reliability of the research there are four threats to the research reliability. Participant error, participant bias, observer error, and observer bias. To say something about the four terms presented above an evaluation of how the Directorate of Fisheries collects their data is needed. The Directorate of Fisheries collects their data using a survey as the research strategy. The data is collected at a company level which means that a company can have operation that covers multiple permits. In addition, they collect the financial statements for the companies that are included in the survey. The companies the Directorate of Fisheries contacts are obligated to answer their survey by § 24 in Akvakulturloven (Akvakulturloven, 2005). The Directorate have their own statistics department where they process the data both manually and automatically. They perform multiple calculation on the collected data, but they only publish average data on a company level. The Directorate has defined three possible sources of errors that can be connected to their collection and interpretation of the data. Measurement and processing error, defection error and sampling error. Measurement errors covers the fact that the companies that answers the survey might not understand the question or answer the question in another way that was first intended. Defection error is the companies has not answered the survey to the extended that it was intended. If they do not, they will be contacted by phone or email. The defection error in the research is on average at 15 %. Some answers to the survey must be omitted from the results because for some corporate reason, acquisition etc, makes it impossible to collect data from the entire accounting year. (Directorate of fisheries, 2019a)

For my collection of the data needed in the bioeconomic model is quite specific with the data needed calculate the optimal rotation length. If the research is to be replicated, they would need to collect the same variables as I have collected. As a result, we can expect other researchers to obtain similar results to what I have accomplished. In addition, the Directorate of Fisheries is the only organization that have collected data that is needed to use the bioeconomic model. Which means that other researchers will use them or conduct their own data collection. As a result, they can expect their results to yield the same as mine.

Due to the formulation of the research question and the strictly constructed theoretical framework that is used it is easy and transparent to give conclusions about what happens to the rotation time. Which means that there is not much room for research error and researcher bias in the interpreting of the results of the bioeconomic model.

5.3.2 Validity

Validity can be separated into internal validity and external validity. Internal validity is affected by the research design and the method used to collect the data. External validity to which extent you can generalize your findings to a larger group. These two terms pull in different directions. To get a good internal validity one need to construct a rigorous research design. Which means that the research becomes narrower in order to answer a specific research question.

In terms of external validity there is obvious benefits of using secondary data that is publicly available. The data is easy to collect, and the research is therefore easy to replicate and reproduce. Another factor that should be mentioned is that the selection of the permits that are included in the data from the Directorate of fisheries is on average over 60 % of the total population. However, their data does not state which production area their selection represents. Because the sample represents a large share of the total population of permits It can be argued that the data represents a good external validity as the data can be generalized and give a good representation for the permits that are not included in the sample. As the companies are obliged under law to give the needed data to the Directorate of Fisheries this increases the validity of the data.

One weakness that is important to highlight when it comes to the research design is because of time constraint I only use quantitative data to answer the research question. To create the bioeconomic model and find the needed input I only needed numerical data. But quantitative methods do in general not uncover social phenomenon where human decision making is an important factor. In the analysis I am assuming that if the rotation time changes the economic behaviour will change, because the companies want to optimize their business decisions, but this might not be the case in real life where people are not 100 % efficient. In order to take some of these humanistic factors into consideration using some qualitative data would increase the validity of the research.

6. Analysis

In this chapter, I will calculate the weight per fish, optimal rotation length, and profit after the different tax structures that are proposed by the tax commission and the Ministry of Finance. In section 6.1 I will estimate the price function. In section 6.2 the different parameters that are as input in the bioeconomic model will be presented. Furthermore, in section 6.3 I will calculate the optimal rotation time assuming zero costs and later introduce costs and corporate income tax. After that, in Section 6.4 I will introduce the resource rent tax structure proposed by the tax commission and investigate if the optimal rotation time will change. In Section 6.5 the production tax will be introduced. In section 6.6 a comparison of the two proposals will be showed and in section 6.7 the limitations of the model are presented.

6.1 Estimation of Price Function

In this section I will present the price function which is derived from the data set collected from the Nasdaq Salmon Index. Pettersen and Hamarsland (2018) estimated a price function using data from the Nasdaq Salmon Index in their research about the economic effects of the production area regulation. A possibility could be to use their price function but with the big fluctuations and increase in the price of salmon in the last few years I find it necessary to estimate a price function based on the most recent data possible. This will ensure that the optimal rotation time and the potential impacts of introducing the tax proposals represent today's market structure. The process of calculating the price function very much resembles Pettersen and Hamarslands method of estimating the price function. (Pettersen & Hamarsland, 2018, pp. 44-57)

6.1.1 Structural Model

To estimate the optimal rotation length, it is necessary to have an assumption of the price of the salmon. Asche and Bjørndal (2011) suggests that the price should be a function of the weight (Asche, 2011, p. 121). Meaning that the bigger the fish grows the higher price you can sell it for.

In order to find a price function, I will have to find a function that visually look like a good fit for how the price develops as the individual fish grows. In Figure 11 you can observe the average price given a certain weight. The average price is calculated using data from 2013 to 2018. The red line is a quadratic trendline that seems to fit good for the existing data.

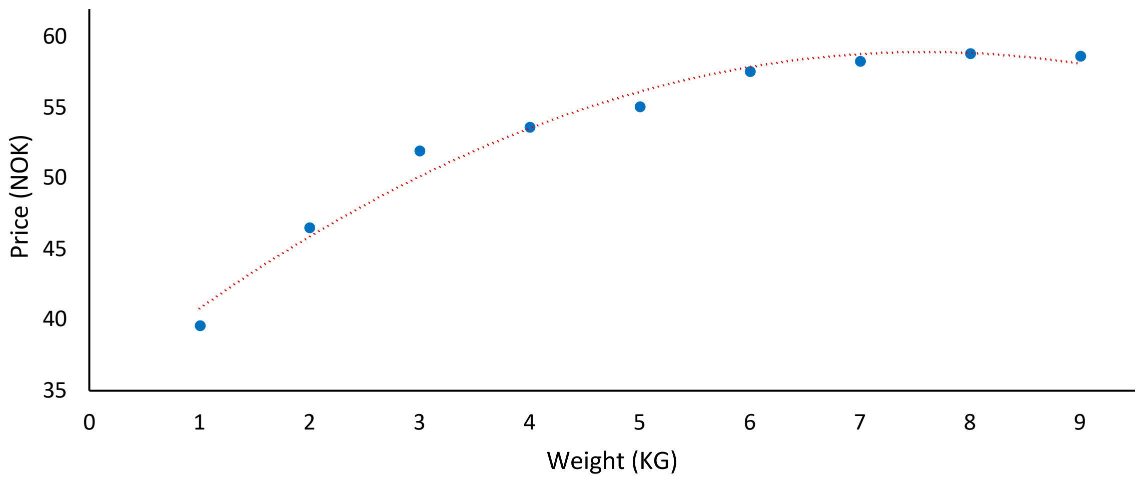

Figure 11 - Average Price per kg from 2013 to 2020 with a Quadratic Trendline

Hence the price function will take the shape off:

$$p(w(t)) = \beta_1 + B_2 w(t) + \beta_3 w(t)^2$$

In the data retrieved from the Nasdaq Salmon Index each observation of price per kilo also have information about year and week as categorical variables. Asche (2002) argues that the salmon price has fixed effects by month and year as different weight classes follows different month dependent price patterns (Asche, 2002). In order to get a more reliable price function I am going to take fixed effects of these two variables into consideration. The price function will therefore take the following form:

$$p(w(t)) \ = \beta_1 + \beta_2 w(t) + \ \beta_3 w(t)^2 + \delta \ month + \gamma \ year + \varepsilon$$

The price data obtained is going the be adjusted for inflation with 2015 as the reference year. The adjustment will be based on data from the Norwegian consumer price index and it is collected from Statistic Norway. (Statistics Norway, 2020). The fixed effects by month is represented with the variable δ and for the year it is represented by γ. The variables for month and year are dummy variables, where there will be created a dummy for each of the months and each of the years in the data set. The ε represents the error term.

6.1.2 Regression Evaluation and Results

In the table below the result of the regressions is presented.

Table 5 - Regressions Results

	1	2	3
Weight	6,052	6,052	6,052
	(0,330)	(0,224)	(0,208)
Weight^2	-0,400	-0,400	-0,400
	(0,032)	(0,022)	(0,020)
Constant	33,378	25,532	28,851
	(0,718)	(0,612)	(0,731)
Year FE	No	Yes	Yes
Month FE	No	No	Yes
N	3267	3267	3267
Adj. R^2	0,22	0,64	0,69

Standard errors in parentheses. Month and Year dummies not reported.

The adjusted R^2 represents how accurate the model is in predicting the price per kg. Before taking fixed effects of month and year the model has an R^2 of 0,22. Including the fixed effects for year the model has an R^2 of 0,64. And including fixed effects for year and month gives us an R^2 of 0,69. When the fixed effects are introduced the first and second-degree component of weight is not affect, but the constant changes. All the variables are significant at a 99 % level. the constant and the coefficient of the first-degree weight variable is positive while the second-degree component of weight is, as expected, negative. With this I conclude that a quadratic price model explains how the price changes as a result of weight.

6.1.3 Regression Validation

To say something about the validation of the regression results I will run post-regression estimations of price for the three different regression models presented in the previous section. In order to determine the validation, I will investigate the mean absolute error (MAE) and mean absolute percentage error (MAPE). MAE is measure of errors between paired observations expressing the same phenomenon. MAPE is a measure of prediction accuracy. The prediction is estimated using the parameters of time and do not include fixed effects of month and year. As Pettersen and Hamarsland (2018) I do not separate the data into separate estimation and prediction parts. Making out-of-sample predictions in this case would lead to an underprediction of the price as the price level is considerable higher at the end of the data period. (Pettersen & Hamarsland, 2018, p. 57)

Table 6 - Prediction Errors of the Price Model

	1	2	3
MAE	8,73	5,84	5,34
MAPE	18,06	11,80	10,72

As you can see the first regressions has the highest MAE and as the fixed effects of year and month are introduced the prediction error decreases. The MAE implies that the average absolute error in price estimation is between 8,73 and 5,34 NOK And the MAPE implies that the price predictions deviate with 18,06 % to 10,72 % from the real observed values. It is expected for an estimated price function to have a certain degree of deviation from the observed value. The conclusion regarding the price function is that it can be used in the analysis and the preferred price is function is number 3 as it yields the largest R^2 and has the lowest MAE and MAPE.

6.2 The Base Model

In this part I will introduce and explain the base model that are used in this analysis. The next step will be to introduce new factors to the model, but the base will stay the same regardless of which of the tax proposal is included. The calculations will be performed on a permit level.

6.2.1 Growth Function

In order to calculate the optimal rotation time, I will use the growth function presented by Guttormsen in his report about using Faustmann's theory in Aquaculture (A. G. Guttormsen, 2008, p. 407). The growth function is slightly updated model from Bjørndal (1990). The update and changes are done due to the fact that Bjørndal (1990) growth function is based on growth numbers from 1988. With improved technology and more evolved feeding processes etc. means that the growth of the fish has increased since 1988. The growth function takes the following form.

$$w(t) = 2{,}8t^2 - 0{,}7t^3$$

In Figure 12 you can see how the weight if the individual fish will develop over time. The individual fish will reach its maximum weight after about 31 months.

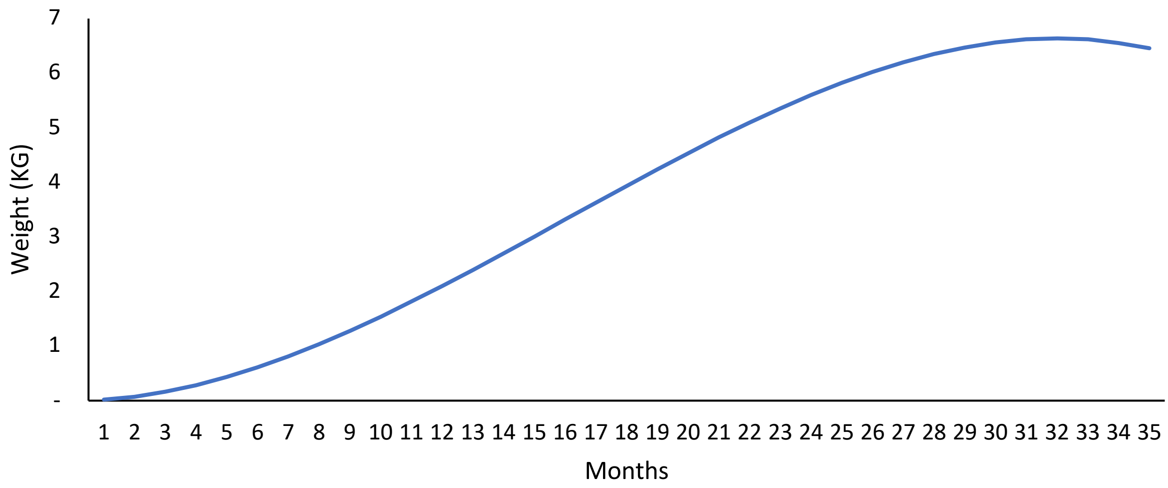

Figure 12 - Weight of the Individual Fish at Different Time Periods

6.2.2 Price Function

From the data I obtained from the Nasdaq salmon index I concluded that the price function can be expressed as a quadradic function. The price function and the estimation of it is further explained in chapter 6.1.

$$p\big(w(t)\big) = \beta_1 + B_2 w(t) + \beta_3 w(t)^2$$

Where: $\beta_1 = 28{,}851\ , \beta_2 = 6{,}052, \beta_3 = -0{,}400$

The value of the total biomass can be expressed as $p\big(w(t)\big)w(t)$. In Figure 13 you can see how the value of the biomass evolves over time.

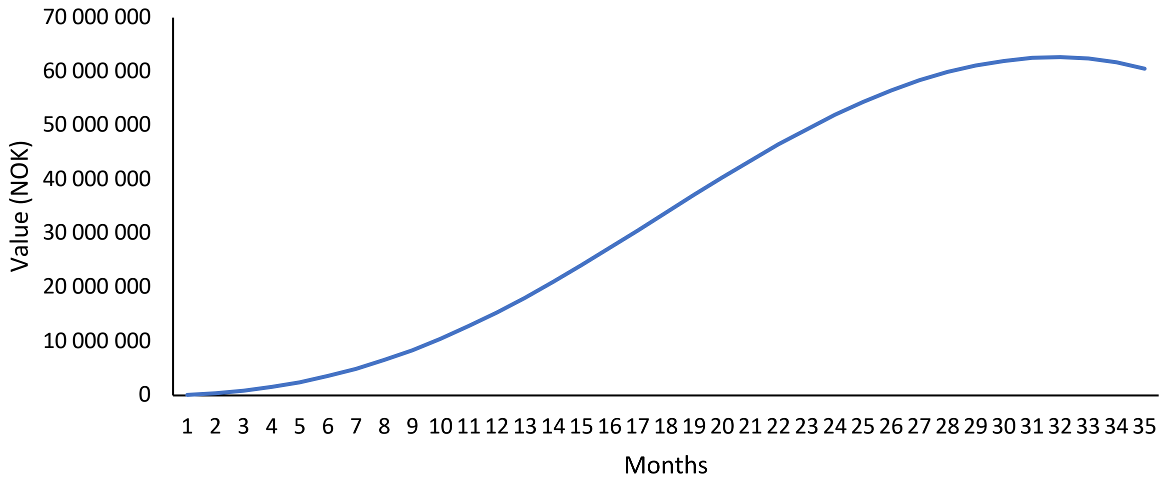

Figure 13 – Value of the Total Biomass at Different Time Periods

6.2.3 Profit Function

In order to determine the net present value of the optimal rotation time I will use a profit function that assumes an infinite number of rotations.

$$\pi(t) = \frac{V(t)}{e^{rt*} - 1}$$

6.2.4 Recruits, Interest- and Mortality Rate

The number of fish in an individual pen should never be bigger than 200 000. This is regulated by akvakulturforskriften (Akvakulturforskriften, 2008). Assuming that the companies are wanting to maximize their profit, one is to assume that they would want to release as much smolts as possible.

The interest rate is set at 6 % to reflect expected return on investments in the Norwegian market. It is based on PwC's report about the risk premium in the Norwegian market. Their report states that the market risk for 2019 is on average 5 %. (PricewaterhouseCooper, 2019). The risk-free rate are determined by the value of 10-year Norwegian government bond and the rate is currently at just under 1 %. (Norges Bank, 2020) Which gives us an interest rate set at 6 %.

The mortality rate used in the model is calculated using the average from the 13-production areas that is defined by the Norwegian government. The average rate is calculated based on

Pettersen and Hamarsland (2018) research from 2018. The average mortality rate is set at 0,01061. (Pettersen & Hamarsland, 2018, p. 61).

6.2.5 Harvest- and Production Costs

Harvest Costs

Harvest cost is a one-time cost in each cycle calculated from the total biomass. The size of the harvest tax is collected from the Directorate of Fisheries. As the parameter for harvest cost, I will use the average harvest cost from the time period between 2008 and 2018. It will be set at 2,82 NOK per kg. This number includes shipment costs. (Directorate of Fisheries, 2020)

Production Costs

The production costs are determined by the cost per kg of feed, the number of fish in each pen and the marginal growth rate of the fish. In order to simplify the calculation of the production cost it will be assumed that the production cost is related to the total biomass and we can therefore measure it by calculating the product between the biomass and the parameter for production costs. The production costs include smolt, feed, insurance, labour depreciation other operation and net finance costs. All the costs are given by NOK per kg and are collected from Directorate of Fisheries. The production cost is set at 23,54 NOK per kg. (Directorate of Fisheries, 2020)

6.2.6 Production Area Constraints

The production area constraints are set at 780 000 kg for production area 1-9 and 945 000 kg for area 10-13 (Fiskeridirektoratet, 2016)

I have now presented all the parameters that will be used as input in the bioeconomic model. In the table below you can find a summary of the parameters.

Table 7 - Summary of Factors in the Calculation of Optimal Rotation Length

Summary of factors		
Growth function	Guttormsen based on Bjørndal (2008)	
	a	2,8
	b	0,7
Price function	Derived from Nasdaq Salmon Index	
	β_1	28,851
	β_2	6,052
	β_3	0,400
Mortality rate	Average mortality rate per pen	0,0106
Recruits	Allowed recruits per pen	200 000
Harvest cost	Average harvest cost per kg biomass	2,82
Production costs	Average production cost per kg biomass	23,54
Interest rate	p.a	0,06
Production area constraint	Maximum allowed biomass	
	1-9	780 000
	10-13	950 000
Tax value of assets (one permit)	Assets needed to operate one permit	10 005 154
Uplift rate	Rate of the uplift	0,007
Tax	Corporate income tax	0,22
	Resource rent tax	0,4
	Production tax (per kg biomass)	0,4 NOK

6.3 Optimal Rotation Time

I will now present the result of the calculations. First, I will calculate the model with zero cost and stepwise introduce harvest- and production cost, and corporate income tax. Doing this I calculate the optimal rotation time before any resource rent tax or production tax is taken into consideration. All the profits are calculated by assuming an infinite number of rotations.

6.3.1 Zero Cost

To stay true to the original model I will fist calculate the optimal profit assuming zero costs. Using the parameters presented above I find that the optimal rotation period with zero costs and no taxation is 18,78 months and the profit will be 18 561 642 NOK.

6.3.2 Intoducing Harvest- and Production Costs

When harvest- and production cost are introduced the optimal rotation period changes. The optimal rotation time increases to 21,12 months and the profit will decrease to 8 392 232 NOK. As the rotation time lengthens, we can assume that harvest- and production cost is decreasing the marginal value of continuing a rotation.

6.3.3 Introducing Corporate Income Tax

As explained in Chapter 4 a profit-based tax will in theory not affect the optimal rotation time. This is confirmed in this model. When introducing the corporate income tax of 22 % the optimal rotation time does not change. The optimal rotation time will still be 21,12 months and the profit will be 6 545 941 NOK.

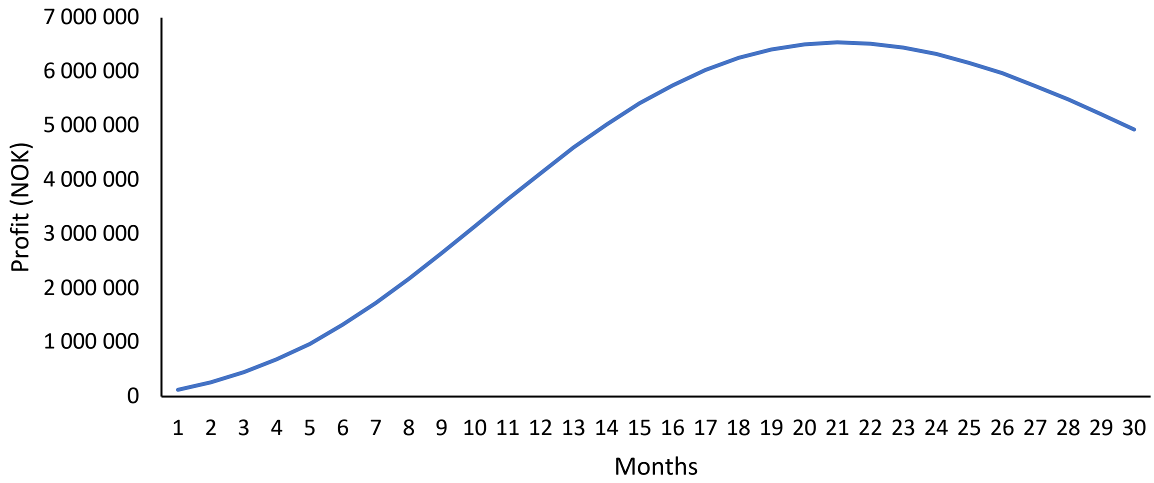

Figure 14 - Profit Assuming an Infinite Number of Rotations at Different Time Periods After Corporate Income Tax

6.3.4 Introdcuing Production Area Regulation

When there is no MAB regulation included in the calculations the optimal rotation time is 21,12 months. At this time the total biomass is at 953 647 kg. Which means that biomass is larger than what the regulation allows for both production area 1-9 and the regulation for area 10-13. Taken the MAB regulation of 780 000 kg into consideration the optimal rotation time decreased to 18,08 months and the optimal profit will be 6 271 140 NOK. Using the regulation for area 10-13 the optimal rotation length will be 20,96 months and the profit will be 6 545 221 NOK. Both the capacity constraints are decreasing the rotation time, but as the regulation for area 1-9 is stricter the regulation affects those areas more than 10-13. For area 1-9 the decrease in rotation time is 14,40 % and for area 10-13 the change is 0,76 %.

Table 8 – Introducing the Production Area Constraints

	Profit	%	Rotation time	%	Biomass	%
No MAB	6 545 941,47	0,00 %	21,12	0,00%	953 647	0,00 %
Area 1- 9 (780)	6 271 140,68	-4,20 %	18,08	-14,40 %	780 000	-18,21 %
Area 10 - 13 (945)	6 545 221,01	-0,01 %	20,96	-0,76 %	945 000	-0,91 %

6.3.5 Summary of Optimal Rotation Time

Here is a summary of the calculations conducted above where harvest- and production cost, corporate income tax base and the production area regulations are stepwise included.

Table 9 - Summary Optimal Rotation Time with Stepwise introduction of Costs, Taxes, and Production Constraints

	Profit	Rotation time
Zero Cost	18 561 642,40	18,78
Including Costs	8 392 232,65	21,12
Including Costs and Corporate Tax	6 545 941,47	21,12
Including Costs, Corporate Tax and MAB (780)	6 271 140,68	18,08
Including Costs, Corporate Tax and MAB (945)	6 545 221,01	20,96

6.4 Introducing The Majority Proposal From the Tax Commision

To this point I have calculated the optimal rotation time introducing harvest- and production cost and corporate income tax. From this point I will start to introduce the different tax proposals. I will start with the profit-based tax proposed by the majority proposal before I look at the production tax proposal from the Ministry of Finance.

6.4.1 Production Tax to Muncipalities

As explained in Chapter 3 the commissions proposed that the local municipalities should get a production tax based on the total biomass of fish within their borders. As the commission did not specify what rate they will give to local municipalities, I will instead assume that both the municipalities and the central government parts of the resource rent tax will be included in the 40 % calculated from the special tax base.

6.4.2 The Special Tax Base: Net Resource Rent Income

As explained in Chapter 3 the resource rent will be calculated from a special tax base called net resource rent income. I will assume that there are no profit or loss for sold assets. The deductibles are almost the same used for harvest- and production cost per kg. But the cost of net finance is not included, and the structure of the uplift is added. In Figure 15 you can see how the tax base should be calculated.

	Gross revenue
+	Realized profit for assets used in aquaculture
=	Gross resource rent income
-	Production cost connected to aquaculture
-	Property tax, research- and development costs
-	Tax related depreciations connected to aquaculture operations
-	Realized loss for assets used in aquaculture
-	Uplift (Friinntekt)
=	Net resource rent income

Figure 15 – Resource Rent Tax Base (NOU 2019:18, 2019, p. 143)

The resource rent tax comes in addition to the corporate income tax. The calculations of the resource rent tax very much resemble how the corporate income tax is calculated. The difference being the factors that are considered deductible and the size of the tax rate.

6.4.3 Profit-Based Resource Rent Tax

Assuming infinite number of rotations, taking harvest- and production costs, corporate income tax and resource rent tax into consideration the optimal rotation time will be 21,13 months and the optimal profit will be 3 162 415 NOK. This is a 0,02 % decrease in rotation time from before the resource rent tax was introduced. This indicates that the structure of the resource rent tax proposed by the tax commission is a good proposal when it comes to the distortionary effects on the optimal rotation time. The optimal rotation times does theoretically change and are therefore by the definition from Amacher et.al (2009) not considered neutral. But because the change is so small it will in reality be insignificant for the salmon farming companies. The economic significance of the tax distortions can be measured by the tax wedge created by the introduction of the resource rent tax. The tax wedge can be determined by calculating the difference between the optimal pre-resource rent tax profit and the pre-resource rent profit but using the rotation time that optimizes the post-resource rent tax profit. We can therefore express the tax wedge as: $\pi(t^*) - \pi(t)$. Where $\pi(t^*)$ is the optimal profit after corporate income tax and $\pi(t)$ is the profit after corporate income tax using the rotation time that maximizes the profit after resource rent tax. Doing this, we can see that the tax wedge created by the introduction of the resource rent tax is 0,35 NOK. In Table 10 the MAB constraints are included. And in Figure 16 the profit after resource rent for different time periods are outlined. As before, the total biomass in the optimal solution will still grow above the MAB constraints. This means that the production will still be restricted by the production area regulation. Comparing the result after resource rent tax with before we can observe that the rotation time after including the MAB constraint will stay at 18,08 and 20,96 with tax distortions of 274 800 NOK and 720 NOK. It those cases the production cycles are unchanged, and the tax can be considered neutral by the definition presented by Amacher et.al (2009). In the table below the changes in profit, rotation time and biomass in the first row are calculated based on the first row in table 8.

Table 10 - Profit After Resource Rent Tax with Rotation Time

	Profit	%	Rotation	%	Biomass	%	Tax distortion
No MAB	3 162 415,59	-51,69 %	21,13	0,02 %	953 837	0,02 %	0,35
Area 1-9 (780)	3 029 405,32	-4,21 %	18,08	-14,41 %	780 000	-18,22 %	274 800,79
Area 10-13 (945)	3 162 051,93	-0,01 %	20,96	-0,77 %	945 000	-0,93 %	720,45

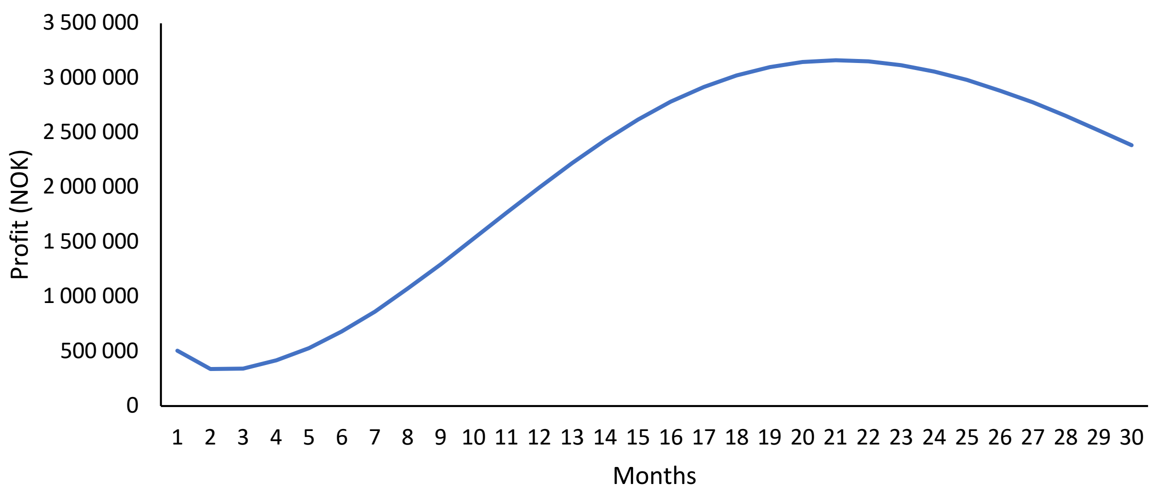

Figure 16 – Profit After Resource Rent at Different Time Periods.

6.4.4 Uplift

The structure of the resource rent tax base is highly important when it comes to the distortionary effects of the resource rent tax. The three factors that decides the size of the resource rent tax base are revenue, deductibles and the uplift. I will start the analysis with investigating the uplift. The uplift is calculated by the value of assets needed to operate one permit multiplied with the specified rate decided by the government. The value of the assets used in the calculation is collected from the Directorate of Fisheries and is the average value in the balance sheet in the time period between 2013-2018 under the name "Oppdretsutstyr og båter" (Directorate of Fisheries, 2020). I decided not to include the value of the post under the name "Driftsløsere". The reason being that there is not enough evidence to link the movables to the actual production process in the sea where the resource rent is created.

As the structure of the tax have been based on the hydropower taxation model it is fair to assume that the rate for the uplift is going to be the same for the aquaculture industry. It is set at 0,7 % as they use 12-month government issued bonds. (Pwc, 2019). This has been a topic of discussion by industry participants. The assets in the aquaculture industry have different depreciation rules than the hydropower industry. It can be argued that the commission should have looked to other solutions when determining the rate (KPMG Law Advokatfirma AS, 2020). The assets needed in the petroleum industry have a more similar depreciation profile to the aquaculture industry. In the petroleum industry they get 5,3 % over 4 years meaning a total of 21,2 %. (Skatteetaten, 2019).

In the majority proposal the commission states that the value of the permits should not be included in the calculation of the uplift. As the permits are very valuable this would possibly be a significant factor in the size of the uplift and therefore the optimal rotation time. Using the value from the auction in 2018 a standard permit of 780 000 kg is valued at 93,6 million NOK. (Arnason & Bjørndal, 2020, p. 13) If we include the permit the uplift will become almost 10 times as large as without the value of the permit and the optimal rotation time will change from 21,13 months to 20,80 months, a decrease of 1,53 %. Including both of the factors discussed, meaning that the value of the permit is included in the base of what the uplift is calculated from and an increase in the rate we get an optimal rotation time of 17,41 months, which is a decrease of 17,61 %. From these calculations we can clearly see that the size of the uplift does matter when it comes to rotation time. The rotation time shortens the bigger the uplift is. All these estimations are done without including the capacity constraints.

The size of the uplift, assuming that the value of the assets is 10 005 154 NOK and that the rate is 0,7 % is 70 036 NOK. Assuming that the assets stay constant over time I can observe that the optimal rotation time will decrease from 21,13 months to 20,90 months if the rate is changed from 0,7 % to 5,3 %. As you can see from the table below the distortionary effects is bigger if the permit is included and the rate is changed. This indicates that the original proposal from the tax commissions is the best proposal when it comes to the distortionary effects on the rotation time.

Table 11 – Analysis of the Uplift

Value of permit included	Rate	Size of the uplift	Rotation	%	Tax distortion
No	0,70 %	70 036,08	21,13	0,02 %	0,35
No	5,30 %	530 273,15	20,90	-1,05 %	1 387,95
Yes	0,70 %	725 236,08	20,80	-1,51 %	2 888,34
Yes	5,30 %	5 491 073,15	17,41	-17,60 %	413 189,11

6.4.5 Changes in the Value of the Assets Needed to Operate One Permit

The model created is assuming that the value of the assets needed to operate one permit is constant. This might not be the case. In 2013 this number was 7,2 million NOK and in 2018 it was 13,23 million NOK. For the base of my calculation I used the average from 2013 to 2018 meaning that the value of the assets is already higher than what I have used in my original calculations. In the last five years the value of the assets has almost doubled on a permit level. As it is the base of what the uplift is calculated from it can be interesting the see how it will affect the optimal rotation time if the value of the assets is bigger. All calculation is assuming that the rate is fixed at 0,7 %.

Table 12 - Increase in Value of Assets Needed to Operate One Permit

Δ in the value of the assets	Value	Uplift (0,7%)	Rotation	% change in rotation	Tax distortion
0 %	10 005 154	70 036,08	21,13	0,02 %	0,35
50 %	15 007 731	105 054,11	21,11	-0,06 %	5,01
100 %	20 010 307	140 072,15	21,09	-0,14 %	25,77
200 %	30 015 461	210 108,23	21,06	-0,30 %	116,09
300 %	40 020 615	280 144,30	21,03	-0,47 %	272,46

After investigating the different factors that determines the size of the uplift it is clear that the size of the assets needed to operate one pen is not the most influential factor. If the value of the permit is included or not has a much greater impact on the rotation time. And if both are done at the same time it will have big impacts on the rotation time.

6.4.6 Changes in the Deducibles in the Resource Rent Tax Base

Another topic of discussion is if the harvest cost should be considered deductible in the resource rent tax base (Vennemo & Bjerkmann, 2018). The majority proposal states that all production cost before the salmon is taken up from the sea should be considered deductible. The harvest and shipping cost can be categorized as a sort of grey zone where there are arguments in favour of including them but also against including it. As the companies have a completely integrated business where they control the different production steps it is clear that harvesting and shipment is an important part of the production process. But the commission states shipment cost to the end consumer should not be deductible in the tax base. Neither should further processing of the salmon. However, shipment to the slaughterhouse should be considered deductible. I will now investigate what happens with the optimal rotation time if the harvest- and shipment cost is not considered deductible from the resource rent tax base.

Table 13 – If Harvest Cost is Considered Deductible or Not in the Calculation of the Resource Rent Tax Base

Harvest cost included	Profit	%	Rotation	%	Tax distortion
Yes	3 162 415,59	0,00 %	21,13	0,02 %	0,35
No	2 743 948,98	-13,23 %	21,57	2,12 %	5 607,46

The table above shows that the optimal rotation will become 2,11 % longer if the harvest cost is not deductible in the resource rent tax base and the profit will decrease 13,23 %. What we can observe is that in the optimization of the profit after resource rent tax is that the profit is higher the bigger the deductibles from the resource rent tax base are. It works in the opposite direction of the deductibles from the corporate income tax base. Therefore, when adding deductibles in the resource rent tax base, profit will increase.

6.5 Introducing the Production Tax Proposal From the Ministry of Finance

As presented in Chapter 3 the Ministry of Finance has proposed a production-based tax that shall be calculated from the production of salmon measured in kg. As explained in Chapter 4 when a production tax is introduced, we can expect the optimal rotation time to change. The question is how much it changes as a result of the tax. In order to investigate this proposal, I go back to the base model presented in section 6.3 where the structure of the resource rent tax is not included.

6.5.1 Introducing Production tax of 0,4 NOK per KG

Given a production tax of 0,4 NOK per kg based on the produced salmon the optimal profit will be 6 396 595 NOK and the optimal rotation time will be 21,20 months which is an increase of 0,34 % compared to before the production tax. The tax will create a tax wedge of 146,75 NOK which is considerable larger than the tax wedge for the profit-based resource rent tax. Though, it is still relatively small and pretty insignificant on the rotation time. Comparing the profit and rotation time with the same numbers after corporate tax we can see that the introduction of a production tax will decrease the profit with 2,28 %. Below, is a table who outlines the changes and a figure who shows how the optimal profit changes over time. The changes in the first row in is based on the first row in table 8.

Table 14 - Changes in Optimal Rotation time as a Result of Production Tax

	Profit	%	Rotation	%	Biomass	%	Tax distortion
No MAB	6 396 595,49	-2,28 %	21,20	0,34 %	957 539	0,41 %	146,75
Area 1-9 (780)	6 111 903,84	-4,45 %	18,08	-14,69 %	780 000	-18,54 %	274 800,79
Area 10-13 (945)	6 395 093,33	-0,02 %	20,96	-1,09 %	945 000	-1,31 %	720,45

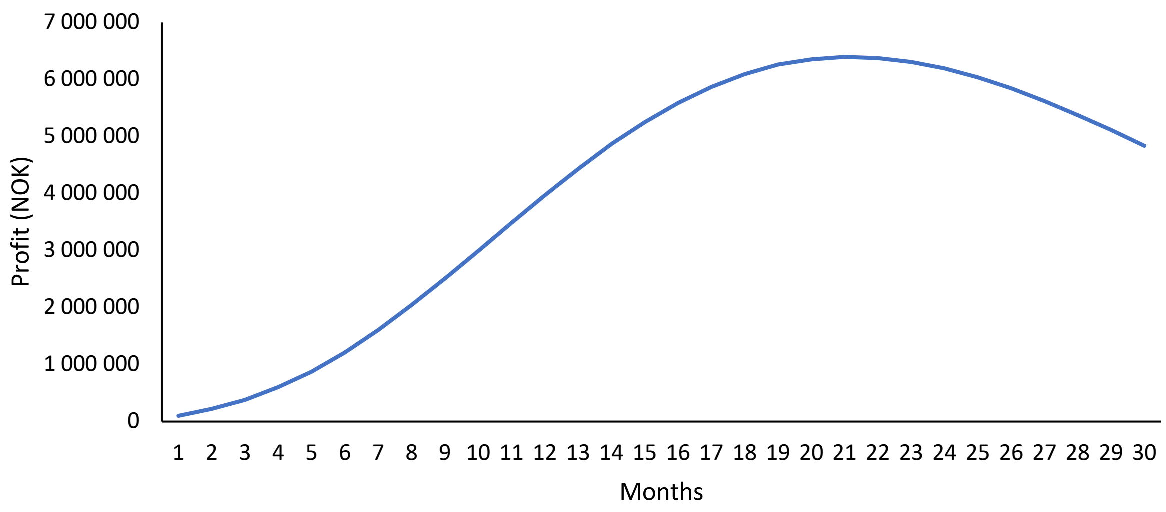

Figure 17 - Optimal Profit over different time periods with Production tax of 0,4 NOK per kg

This result confirms the theory on yield and unit taxes presented in Amacher et.al (2009) where they state that a yield or unit tax will lengthen the rotation time because the opportunity cost of continuing a rotation will be reduced as a result of introducing the unit tax (Amacher et al., 2009, p. 31).

One interesting result we can observe from the table above is that when the MAB constraints are introduced the optimal rotation time is the same as when we introduced the MAB constraints for the profit-based resource rent tax. This means that the tax distortions are also equal for both the tax proposals. One could argue that in these cases it does not matter how the government decides to collect their taxes as the companies will behave the same way regardless. Assuming that the potential behavioural changes is only determined by a change in optimal rotation time.

6.5.2 Increase in Production Tax

As we can see from the calculations above the production tax will have a small effect on the rotation time given the terms presented by the Ministry of Finance. One is to assume that if the tax would be bigger the tax would have a greater impact on the rotation time. The companies are subjected to a certain political risk that this production tax might increase if the industry continues to be as profitable as it is today. In the table below the changes in the rotation time as a result of a greater tax rate is outlined.

Table 15 - Increase in Production Tax

Δ in tax	NOK per kg	Rotation	%	Tax distortions
0	0,4	21,20	0,34 %	146,75
50 %	0,6	21,23	0,52 %	333,59
100 %	0,8	21,27	0,69 %	599,20
150 %	1	21,31	0,87 %	945,99
200 %	1,2	21,35	1,05 %	1 376,48

The increase in the size of the tax has a very limited effect on the rotation time. The production tax work as a decrease in the net price it is possible to obtain for the salmon. A reason may be that the profit margin in the industry is at around 20 NOK per kg salmon when sold at the optimal rotation time. Meaning that a production tax of 0,4 NOK and up to 1,2 NOK per kg is not big enough to create a big distortion in the optimal rotation time. Because of this observation it can be interesting to investigate what happens with the optimal rotation time if the profit margin decreases but the tax stays the same.

6.5.3 Change in Profit Margin

A reason to why the production tax has a small effect on the optimal profit- and rotation time is because the profit margin in my calculations is very high. Looking at the profit margin per kg in the optimal rotation time gives us a price of 48,84 NOK and a cost of 26,36 NOK resulting in a profit margin of 22,48 NOK per kg. Meaning that a production tax of 0,4 NOK only accounts for 1,78 % of the profit margin. However, if there is a sudden price or cost shock in the industry, which is probable as the industry is volatile, this will change. One possible scenario that can happen is that there is created a production method that makes it more efficient to produce the fish which will lead to increased supply which will lead to the price dropping.

Table 16 - Change in Profit Margin

Δ in Cost (NOK)	Profit Margin (NOK)	Tax / Margin	Rotation	%	Production tax	%
0	22,50	1,78 %	21,20	0,34 %	383 015	0,00 %
5	17,95	2,23 %	22,00	4,13 %	399 866	4,40 %
10	13,44	2,98 %	23,03	9,00 %	420 448	9,77 %
15	8,99	4,45 %	24,44	15,69 %	446 289	16,52 %
20	4,58	8,73 %	26,68	26,32 %	480 397	25,42 %

As you can see from the table above the production tax changes slightly due to the change in cost. This is because it is based on the salmon produced measured in kg. When the cost is increased, and the profit margin is smaller the rotation time lengthens and the biomass in the pen increases. Resulting in a bigger production tax. When the profit margin decreases, and the production tax only changes slightly the tax will take a bigger share of the profit. And if it becomes big enough it can make a rotation that is profitable before the production tax not profitable after the production tax. Which is one of the main reasons to why the tax commission did not propose this kind of tax in the first place. One can also observe that the increase in cost causes an increase in rotation time.

6.5.4 Change in Basis for Calculation of the Production Tax

As explained above the proposal from the Ministry of Finance states that they would base the production tax on the production of salmon measured in kg. In the tax commissions proposal, they looked at other bases to calculate the production tax. One possibility they discussed was to use the MAB constraints as the base for the production tax. Which means that the size of the tax can be calculated by 780 000 kg or 945 000 kg multiplied with the rate of the tax. Hence, 312 000 NOK or 378 000 NOK if the production tax is set at 0,4 NOK per kg produced salmon. This is an easy way of calculating the production tax that would not require any time-consuming administration changes. If the tax is structed this way the production tax will basically be a constant tax each year unless the companies apply for and are granted an increased production capacity. Even though basing the tax on the production is easy to calculate, basing it on the MAB constraints would be even easier. But as shown in Table 14 the optimal production without the capacity constraints is equal to 957 539 kg. Which means that the MAB constraints will limit the biomass to grow bigger than the constraints. Therefore, in real life where the current MAB constraints exist the tax will be the same in my model regardless of if you base it on production or the MAB constraints.

6.6 Comparison of the two Tax Proposals

I will now compare the main results from the two different tax proposals. The purpose of this thesis was to investigate potential distortions in the optimal rotation time. My research suggests that the distortionary effects on the optimal rotation time is greater for the production tax compared to the profit-based resource rent tax. The optimal rotation time is 21,12 months after the corporate income tax, 21,13 months for the profit-based resource rent tax and 21,20 months for the production tax. In order to estimate the distortionary effects of the tax not only in rotation time, but also the economic significance of the tax distortions we can investigate the size of the pre-tax profits with the tax proposals subtracted from the pre-tax profits before the tax proposals. Doing this we can observe that the distortionary effects of the production tax is 146,75 NOK while the distortionary effects for the profit-based resource rent tax is 0,35 NOK. It is interesting to see that the distortionary effects in terms of rotation time and economic significance of the two tax proposals is equal to each other when the MAB constraints are present. In the table below my main findings are illustrated.

Table 17 - Comparison of the Two Tax Proposals

	Rotation	Tax distortion
Corporate income tax	21,12	0
Profit-based resource rent tax	21,13	0,35
MAB constraints		
1-9 (780)	18,06	274 801
10-13 (945)	20,96	720
Production tax	21,2	146,75
MAB constraints		
1-9 (780)	18,06	274 801
10-13 (945)	20,96	720

In order to get a visual understanding of the differences between the two proposals here is a figure where figure 14, 16 and 17 are plotted in the same graph. As you can see the profit-based resource rent tax will have a much bigger effect on the profitability for the companies. The profit after production tax is almost identical to the profit after corporate income tax. As a result, it can be argued that the economic significance in terms of profitability is bigger for the profit-based resource rent tax compared to the production tax. Still, the distortionary effects on the rotation time is greater for the production tax than the profit-based resource rent tax.

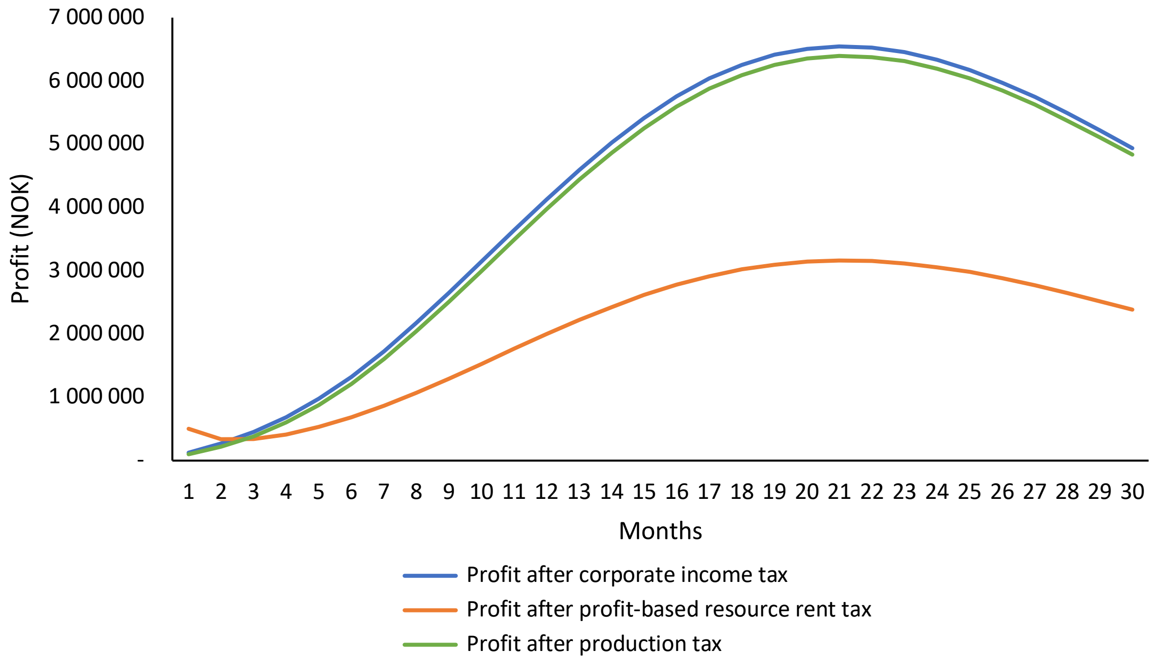

Figure 18 – Visual Comparison of the Different Tax Proposals

6.7 Limitations of the Models

It is important to state that the calculations presented above is calculated on a permit level. The data from the Directorate is presented as the average over a selection of the outstanding permits. But as the companies within the industry differs a lot from each other in terms of size, efficiency, geographical location among other factors this will be different for each individual company. Companies might also have production in more than one production area and have big differences in the factors within their own company.

As explained in Section 6.4.1 the model will be slightly different from the structure that is proposed by the tax commission. I chose to not include the small production tax that would go to the municipalities because the tax commission did not specify the size of it in their proposal. Instead I assumed that the resource rent they is fully captured by the 40 % tax rate.

In terms of the deductibles in the resource rent tax base I have assumed that smolt-, depreciation-, feed-, harvest-, insurance-, labour and other operation costs are considered deductible. This is the same as for the corporate income tax base with the exception of net finance cost not being included. I have assumed that there is no profit or loss from sold assets and that the property market and research tax is eliminated as the commission suggested in their proposal. There are also some limitations to the model related to the uplift and the size of it. It is calculated on the value of that goes under the accounting term “Oppdrettsuttyr og båter”. The value of this accounting term has varied a lot over time. In the last 5 years it has increased from 7,2 million NOK to 13,2 million NOK. The model created assume a one-time invested in an age class of salmon. This means that the assets are considered constant over the infinite rotations and therefore the uplift will remain constant.

For the purpose of this thesis the goal was to investigate if the production cycles would be distorted if the different taxes were introduced. When determining if a tax is neutral or distortionary on economic behaviour many other factors are important to take into consideration and to only base your answer of the neutrality of the tax based on the change in rotation time would be quite shallow. Some of the other factors that should be taken into consideration will be investigated in the next chapter.

7. Discussion

In this chapter I will discuss my results from the previous chapter and look into some of the potential consequences of the nature of the taxes. In section 7.1 I will look into the MAB constraints and how they are affected by the resource rent tax. Section 7.2 the factors that goes into determining the uplift will be discussed. As my analysis only covers the potential change in rotation time as a result of the introduction of the different taxes, I will dedicate section 7.3 to look at other research papers from economics professionals who take other factors into consideration when discussing the neutrality of the two proposals.

7.1 MAB Constraints

As a part of the production area regulation the government has introduced the MAB constraints. Using the numbers, I have obtained for recruits, mortality rate and growth etc. gives an optimal biomass of 953 836 kg for the profit-based resource rent tax and 957 539 for the production tax without using the biomass constraint. If I introduce the biomass constraint for the different production areas the optimal rotation time will be shortened, and the profit will fall. This means the salmon will not grow to its maximum potential because they must harvest their biomass before it has reached its optimal value. But because the constraints are different for the production areas it is likely that the companies might find it more attractive to have production in area 10-13 instead of 1-9 as they are allowed produce more biomass in those areas. And therefore, they can collect more profit assuming that the growth conditions and cost level are identical across the production areas. Because area 10-13 is in the far north of Norway the growth conditions are typically not as good as further south. As a result, there will be a trade-off between having worse growth conditions against being allowed to produce more fish.

For the production tax we can observe that the rotation time will lengthen with the introduction of the tax. This is in line with the theoretical framework on harvest taxes presented in Chapter 4. What is interesting is that to make up for the introduction of the tax the biomass grows, which means that both the production tax and the production cost will grow. This is because we move closer to the maximum sustainable yield. A higher tax rate leads to more production. But in reality, the production is limited by the MAB constraints. Which means that even though the rotation time will in theory lengthen it will not be the case in in reality because of the MAB constraint. As a result of the capacity constraints it can be argued that the salmon farming companies are not really optimizing their businesses decisions anymore. When the MAB constraints are present it does not matter which one of the two proposals the government chooses to introduce because the companies will not change their production cycle regardless. As a result of the optimal rotation time not changing, the tax distortion will be equal to 0. Because the MAB constraint is limiting the optimal profit it will create a shadow value of the production.

In chapter 3 section 3.3.2 I used an example from Ricardo (1821) to explain resource rent and how different farmers have different access to good soil and land areas. The farmers with the best land are able to generate all the potential resource rent, but the farmers with worse land or constraints on their production cannot do so. This is highly relevant due to the production area regulation and the fact that the restriction of 780 000 kg ensures that not all the possible resource rent is possible to extract. The areas where you are allowed to have a maximum biomass of 945 000 kg are extraction more resource rent because of the more relaxed capacity constraint. You can argue that government has created an environment where we can compare the aquaculture industry with Ricardo's example with the farmers. The areas where you only can produce 780 000 kg of biomass can be considered as "bad land areas". The difference in the profit generated is of one factor only, the quality of the soil. Assuming that the reason for the stricter capacity constraint is that the "soils" is not as good as in the other areas.

7.2 Uplift

A factor that should be discussed is the rate used to calculate the uplift. The commission's proposal states that they will use a risk-free rate, which is determined by 12-month government issued bonds. The reasoning behind it being that the payments are as good as guaranteed from the government. But the companies might not necessarily view it that way. You do not need to look further than the proposal itself. It is clear that the companies are subjected to a political risk when involved in aquaculture production. Which rate they should use is a difficult question. If the rate used to calculate the uplift is to high it works as a subside and will promote over-investment in the industry. On the other size if it is to small investments that are profitable might not be initiated and therefore the investment level might be reduced. (Bjerkslund, Nøstbakken, & Moen, 2019)

In the proposal the commission will act as an “silent partner” where they take part in both the good times but also the bad times as negative profit is carried forward to the next year. But because the government will not pay their part right away, meaning the tax deductions, they will compensate the companies with the uplift. The issue in terms of neutrality in this structure is that the government wants to get paid right away, but they want to cover their part over multiple years. As showed in the previous chapter the structure of the uplift is one out of three factors when investigating if the optimal rotation time is changed due to the introduction of the resource rent tax. One solution could be to introduce a cash flow based system instead of a periodized one. (Vennemo & Bjerkmann, 2018, p. 14). In a cash flow taxation structure, the companies receive their tax deductions in the year the it arises, and the uplift is eliminated. Hence, the uplift will not be an issue and not a topic of discussion. This will also be the case if they chose to introduce a production tax instead of a profit-based resource rent tax.

Another topic of discussion is if the price to obtain the permits should be included in the base the uplift is calculated from. My analysis suggests that it makes a difference if it is included or not. In terms of the distortionary effects on the rotation time it can be argued that it should not be included as the rotation time shortens and the tax wedge is higher if it is included. The value of the assets needed to operate one permit is around 10 million NOK and the value of the permit is almost 90 million NOK. Making the base of where the uplift is calculated from ten times larger if the value of the permit is included. One of the issues is that many of the permits have been awarded free of charge. In order for the companies to operate under the same conditions you would need to allow these permits to get uplift also and a potential method that can be used to solve this issue is to take the market price of the permit into consideration.

7.3 Consequenses of Distortionary Taxes

For the purpose of answering the defined research question I used the definition from Amacher et.al (2009) to determine if the resource rent taxes would be considered neutral or distortionary. Where a neutral tax does not distort the optimal rotation while a non-neutral do. In the analysis conducted in Chapter 6 the calculations showed that both the profit and production tax will distort the optimal rotation time if the biomass was to grow to its optimal size. Hence, the tax will not be neutral because it will change the economic behaviour of the companies. Although, when introducing the MAB constraints, the optimal rotation time would be the same regardless of which tax that was used. Because the biomass is not allowed to grow to its maximum potential. As stated earlier in the thesis there are many other factors besides the production cycles that should be taken into consideration when discussed if a tax would be neutral or distortionary. In this section I will discuss some of the potential implications that may occur if the tax is introduced as a distortionary tax. In section 7.3.1 I will look into some of the arguments that are discussed in Bjørndal and Arnason (2020) and in Section 7.3.2 I will look at how the resource rent tax have affected the hydropower industry.

7.3.1 Potential Impacts of Introducing Resource Rent Tax

Arnason and Bjørndal (2020) suggests in a report published in 2020 that there are multiple different impacts a resource rent tax can have if it is implemented. They argue that the tax structure that the commissions proposes resembles more of an extra profit tax, than a resource rent tax. (Arnason & Bjørndal, 2020). The first impact they discuss, and the inspiration behind this thesis, is that it is probable that the companies will alter their production cycle if the tax proposal is introduced. In the previous chapter I estimated the possible changes that might occur if the taxes are introduced. My calculations suggest that when the production cycles will not change because they are forced to harvest when the biomass has reached a certain size because of the MAB constraints.

The second impact is that the tax is reducing the retained profits for the company, it encourages exit and discourages entry into the industry as it makes the industry less attractive to investors. Investors have many different options when it comes to investment opportunities so why should they invest in the Norwegian aquaculture industry when they have the option to invest in other countries with a much smaller tax rate.

The third impact is that the economic risk is increased as a result of less profits being retained by the companies. Less capital available means that the provider of capital has bigger risk associated with lending money. As a result, they will demand a higher return on their capital because the companies retain less profit which can affect future investments and the solidity of the companies (Arnason & Bjørndal, 2020). The combination of less capital available and increased threshold to lend money is not beneficial for investments in the industry. This is confirmed by the Finans Norge who it their consultation response to NOU 2019:18 states that the financial institutions will change the criteria’s they operate with when it comes to lending money to the aquaculture companies. This comes a result of the weakened solidity in the companies. The permits have historically been an important collateral for the companies when lending money. But these permits might drop in value if the tax is introduced. (Finans Norge, 2020, p. 2)

There is a certain political risk involved as well. In their report they use the discussion of introducing the resource rent tax as an example of a political risk the Norwegian salmon aquaculture companies are exposed to. What happens if another industry goes through an evolution and suddenly becomes very profitable? Should this industry have extra taxation just because it is more profitable than others. This will scare foreign investors away.

7.3.2 Experiences From the Hydropower Industry

As the structure of the resource rent tax proposed for the aquaculture industry is based on the structure that is already in place for the hydropower industry, with some minor adjustments, it is fair to look at towards them and see how the resource rent tax have affected their industry. The hydropower industry states that the introduction of resource rent taxation will have big macroeconomic consequences. Energi Norge states in their consultation response to the NOU 2019:18 that their experience of the taxation in the hydropower industry is that it is not a neutral tax. It distorts their investment decisions and economic behaviour. They highlight the electrification that the aquaculture are going through, if the government enforce the resource rent taxation system they are worried that the companies might not go through with the project (Energi Norge AS, 2020, p. 1).

Misund et.al (2019) investigated how the resource rent taxation has affected the hydropower industry and compares it with the aquaculture industry. Their research highlights four important factors (Misund et al., 2019, p. 96). The fist conclusion Misund et.al (2019) presents in their report is that existing production facilities are not upgraded. The companies have less capital available therefore they must choose between upgrading existing facilities or invest in new ones. As a result, investments that initially are profitable is not carried out.

The second is that the resource rent tax system weakens competitive advantages. The production of salmon is constantly disrupted with new technology. One competitive advantage the Norwegian aquaculture industry have on other countries is their low cost, hence good profit margin. But with the introduction of the resource rent tax this will drastically change. It will go from the country with the best profit margin to the one with the worst. Many companies are working on other production methods both on land and in the open sea. In the years to come the competitive advantage of the Norwegian coastline will be drastically reduced. In today's market the geographically structure is a necessary in order to produce salmon, but in the future, this might not be the case. For the Norwegian aquaculture industry to keep their market position they must keep investing in new technology, but this will be altered with the introduction of the resource rent tax.

The third factor Misund et.al (2019) highlights is the fact that tax creditors are paid before investors. Investors are not attracted to the industry because they are paid after the Norwegian government have taken big shares of the profit. Investors interested in the aquaculture industry might look to other countries when making their investment decisions. This also applies for the companies interested in having operation within the aquaculture industry. They might look into the possibility of moving production to a different country abroad. On the other hand, and an argument the commissions favour, is that the even with the resource rent tax Norwegian aquaculture will still be profitable. As a result, somebody will want to obtain permits to operate within Norway. But there may be some restructuring of the companies that have production in the country. Existing companies might leave, and new companies might take over production in Norway.

The fourth factor Misund et.al (2019) highlights are that if they introduce a profit-based resource rent tax the administration costs will rise. Based on the structure the commission propose they state that the resource rent tax should be based on the production where the resource rent is created. Meaning the production that takes place in the sea. But because the production in the sea is not the first or final part of the production chain this can be a challenging affair for the companies. They will have to separate the costs that occur in the sea from costs that occur from the other production steps which will lead to high administration costs and will strongly favour big companies as smaller companies have less resources in administration.

As the Norwegian aquaculture industry is highly integrated where the companies control most of the value chain themselves an introduction of resource rent tax might stimulate tax planning. In the calculation of the resource rent tax base it is so many assumptions and it can be difficult to do it in an efficient matter. They can allocate different costs to the production in the sea hence the resource rent tax base will decrease and therefore they will payable tax will decrease. They will most likely try to keep the production longer on land which in order for the fish to have less time in the sea.

8. Conclusion

As the basis for this thesis I wanted to answer the following research question:

"Will the introduction of a resource rent tax distort the optimal production cycles for the companies within the Norwegian salmon aquaculture industry and what is the magnitude of the welfare loss?"

In order to answer the research question, I created a bioeconomic model based on existing bioeconomic theory and extended the model by first introducing corporate income tax before I introduced the two different tax proposals. By doing this I was able to estimate the change in optimal rotation time before and after the tax proposals was introduced.

My research suggests that the optimal rotation time will change if the majority proposal presented by the tax commission is introduced. Although, the change is very small and in reality, pretty insignificant. If they instead choose to introduce the production tax suggested by the Ministry of Finance, the optimal rotation time will also change. In both cases the rotation time lengthens which indicates that the introduction of the tax is decreasing the marginal value of continuing a rotation. I can therefore conclude that the taxes will act as distortionary taxes. Although, the size of the welfare loss, measured by the tax distortions, was relatively small. 0,35 NOK for the profit-based resource rent tax and 146,75 NOK for the production tax. This conclusion is based on the definition from Amacher et.al (2009) who argues that a tax is neutral if it does not change the rotation time and is distortionary if it does. But as the analysis shows, when taking the MAB constraints into consideration the optimal rotation time will not change with the introduction of the two tax proposals because the companies are forced to harvest their biomass when it has reached a certain size. The MAB constraints ensure that the companies are forced to harvest after 18,08 months in production area 1-9 and after 20,96 months in production area 10-13. As a result of the optimal rotation time not changing, I can conclude that the taxes act as neutral if the MAB constraints are included in the calculations. In those cases, the introduction of the taxes will not change the economic behaviour of the companies.

References

Akvakulturforskriften. (2008). *Forskrift om drift av akvakulturanlegg*. Retrieved from https://lovdata.no/dokument/SF/forskrift/2008-06-17-822.

Akvakulturloven. (2005). *Lov om akvakultur (Akvakultur)*. Retrieved from https://lovdata.no/dokument/NL/lov/2005-06-17-79#KAPITTEL_1.

Altinn. (2019). Tax for personal shareholders in private limited companies. Accessed from https://www.altinn.no/en/start-and-run-business/direct-and-indirect-taxes/the-enterprises-tax/tax-for-personal-shareholders-in-private-limited-companies/

Amacher, G., Ollikainen, M., & Koskela, E. (2009). *Economics of Forest Resources*. Massachusetts Institute of Technology.

Arnason, R. (2010). *On the economic distortion of pure resource rent taxation* Retrieved from https://ir.library.oregonstate.edu/concern/conference_proceedings_or_journals/n009w315m

Arnason, R., & Bjørndal, T. (2020). *Rents and rent taxation in the Norwegian aquaculture*. Retrieved from Seafood Norway: https://sjomatnorge.no/wp-content/uploads/2020/02/Arnason-og-Bjorndal-Report-on-NOU-2019-18.pdf

Asche, F. (2002). *Patterns in the relative price for different sizes of farmed fish* (Vol. 92): Norwegian School of Economics.

Asche, F. (2011). *The economics of salmon aquaculture* (2nd ed. ed.). Chichester: Wiley-Blackwell.

Barentswatch. (2020). Sustainablility in aquaculture - profitability. Accessed from https://www.barentswatch.no/en/havbruk/profitability

Berge, A. (2018). Tungt fall for Norges markedsandel i laks. Accessed from https://ilaks.no/tungt-fall-for-norges-markedsandel-i-laks/

Bjerkslund, P., Nøstbakken, L., & Moen, J. (2019). NHH-professorer tar oppgjør med stavangerprofessorer om grunnrenteskatt: Oppdrettsfinansiert finansteori holder ikke mål. Accessed from https://www.dn.no/innlegg/skatt/grunnrenteskatt/oppdrett/nhh-professorer-tar-oppgjor-med-stavangerprofessorer-om-grunnrenteskatt-oppdrettsfinansiert-finansteori-holder-ikke-mal/2-1-703261

Directorate of fisheries. (2017). Maksimum tillatt biomasse. Accessed from https://fiskeridir.no/Akvakultur/Tildeling-og-tillatelser/Tildelingsprosessen

Directorate of fisheries. (2019a). Lønnsomhetsundersøkelser for laks og regnbueørret. Accessed from https://www.fiskeridir.no/fiskeridir/Akvakultur/Tall-og-analyse/Statistiske-publikasjoner/Loennsomhetsundersoekelser-for-laks-og-regnbueoerret

Directorate of fisheries. (2019b). Nøkkeltall for norsk havbruksnæring. Accessed from https://www.fiskeridir.no/fiskeridir/Akvakultur/Tall-og-analyse/Statistiske-publikasjoner/Noekkeltall-for-norsk-havbruksnaering

Directorate of fisheries. (2020). Production areas. Accessed from https://kart.fiskeridir.no/share/fc279b7d6213

Directorate of Fisheries. (2020). Statistics for aquaculture. Accessed from https://www.fiskeridir.no/fiskeridir/English/Aquaculture/Statistics/Atlantic-salmon-and-rainbow-trout

Direktoratet for forvaltning og IKT. (2015). *Evaluering av fiskeridirektoratet*. Retrieved from https://www.difi.no/sites/difino/files/evaluering_av_fiskeridirektoratet_difi-rapport_2015_1.pdf

Energi Norge AS. (2020). *Høring - NOU 2019: 18 Skattlegging av havbruksvirksomhet*. Retrieved from https://www.regjeringen.no/no/dokumenter/horing--nou-2019-18-skattlegging-av-havbruk/id2676532/?uid=92468632-7471-4da3-bd7f-5a8914722900

Finans Norge. (2020). *NOU 2019: 18 Skattlegging av havbruk – Finans Norges høringssvar*. Retrieved from https://www.finansnorge.no/contentassets/09c3705db88549d8a54c89db67b2f5bb/horingsuttalelse---skattlegging-av-havbruk.pdf

Finansdepartementet. (2019). Skattesatser 2020. Accessed from https://www.regjeringen.no/no/tema/okonomi-og-budsjett/skatter-og-avgifter/skattesatser-2020/id2671009/

Finansdepartementet. (2020). Havbrukskommunene får langsiktige og stabile inntekter fra havbruksnæringen. Accessed from https://www.regjeringen.no/no/aktuelt/havbruk/id2702028/

Fiskeridirektoratet. (2016). Biomasse. Accessed from https://www.fiskeridir.no/Akvakultur/Drift-og-tilsyn/Biomasse

Fiskeridirektoratet. (2019a). Beredskapsveileder ved rømming av fisk. Accessed

Fiskeridirektoratet. (2019b). Rømmingsstatistikk. Accessed from https://www.fiskeridir.no/Akvakultur/Tall-og-analyse/Roemmingsstatistikk

Food and Agriculture Organization of United Nations. (2020). The state of world fisheries and aquaculture. Accessed from http://www.fao.org/3/ca9231en/CA9231EN.pdf

Forskrift om kapasitetsøkning for tillatelser til akvakultur med matfisk i sjø av laks, ø. o. r. i. (2017). *Forskrift om kapasitetsøkning for tillatelser til akvakultur, 2017–2018*. Retrieved from https://lovdata.no/dokument/SF/forskrift/2017-12-20-2397.

Greaker, M., & Lindholt, L. (2019). Grunnrenten i norsk akvakultur og kraftproduksjon fra 1984 til 2018. Accessed from https://www.regjeringen.no/contentassets/207ae51e0f6a44b6b65a2cec192105ed/no/sved/1.pdf

Guttormsen, A. (2014). Hva påvirker laksepriser. Accessed from http://europharma-no.com/downloads/lofotseminar/presentasjoner/Guttormsen.pdf

Guttormsen, A. G. (2008). Faustmann in the Sea: Optimal Rotation in Aquaculture. Accessed from https://core.ac.uk/download/pdf/6541584.pdf

iLaks. (2019). Lakselus kostet oppdretterne minst 5,2 milliarder i 2018. Accessed from https://ilaks.no/lakselusa-kostet-oppdretterne-minst-52-milliarder-kroner-i-2018/

Koskela, E., & Ollikainen, M. (2000). *Forest taxation and rotation age under private amenity valuation: New results*. Pellervo Economic Research Institute.

KPMG Law. (2019). Taxation of aquaculture 2019. Accessed from https://assets.kpmg/content/dam/kpmg/no/pdf/2019/03/Taxation-of-aquaculture-2019-a-country-overview.pdf

KPMG Law Advokatfirma AS. (2020). *Høringssvar - NOU 2019:18 Skattlegging av havbruksvirksomhet*. Retrieved from https://www.regjeringen.no/no/dokumenter/horing--nou-2019-18-skattlegging-av-havbruk/id2676532/?uid=156f8edb-1479-415c-9ced-9e6dab074943

kyst.no. (2018). Bygger landbasert oppdrettsanlegg midt i ørkenen. Accessed from https://www.kyst.no/article/bygger-landbasert-oppdrettsanlegg-midt-i-orkenen/

Kyst.no. (2020). Revidert: Innfører en halv milliard i produksjonsavgift på laks. Accessed from https://www.kyst.no/article/revidert-innfoerer-produksjonsavgift-paa-laks/

Ministry of Trade, I. a. F. (2020). The Directorate of fisheries. Accessed from https://www.regjeringen.no/en/dep/nfd/organisation/etater-og-virksomheter-under-narings--og-fiskeridepartementet/Subordinate-agencies-and-institutions/The-Directorate-of-Fisheries/id1507/

Misund, B., Osmundsen, P., Tveterås, R., Benn, Folkvord, Nystøyl, R., & Rolland, K. H. (2019). *Grunnrenteskatt i havbruk – Et kunnskapsgrunnlag - Faglig sluttrapport*. Retrieved from https://sjomatnorge.no/wp-content/uploads/2020/02/UiS-Sluttrapport-fra-prosjekt-901526-FHF.pdf

Mowi ASA. (2019). Salmon Farming Industry Handbook. Accessed from https://ml.globenewswire.com/Resource/Download/1766f220-c83b-499a-a46e-3941577e038b

Nasdaq. (2019). Nasdaq Salmon Index. Accessed from https://salmonprice.nasdaqomxtrader.com/public/report?0

Norges Bank. (2020). Statsobligasjoner daglige noteringer. Accessed from https://www.norges-bank.no/tema/Statistikk/Rentestatistikk/Statsobligasjoner-Rente-Daglige-noteringer/

NOU 2019:18. (2019). *Skattlegging av havbruksvirksomhet*. Retrieved from https://www.regjeringen.no/contentassets/207ae51e0f6a44b6b65a2cec192105ed/no/pdfs/nou201920190018000dddpdfs.pdf.

NOU 2019:18 Eng. (2019). *Taxation of the aquaculture industry*.

NRK (Producer). (2020). Lakseskatten. Retrieved from https://tv.nrk.no/serie/debatten/202002/NNFA51021120/avspiller

Nyrud, T., Bendiksen, B. I., & Breyer, B. M. (2016). Valuta effekter i norsk sjømatindustri. Accessed from https://nofima.no/publikasjon/1363654/

Pettersen, C. A., & Hamarsland, I. H. (2018). *The economic effects of the production area regulation.* Norwegian School of Economics, Retrieved from https://openaccess.nhh.no/nhh-xmlui/bitstream/handle/11250/2559623/masterthesis.PDF?sequence=1&isAllowed=y

PricewaterhouseCooper. (2019). Risikopremien i det norske markedet. Accessed from https://www.pwc.no/no/publikasjoner/pwc-risikopremie-2019.pdf

Pwc. (2019). Havbruksskatteutvalget foreslår 40 % grunnrenteskatt. Accessed from https://blogg.pwc.no/skattebloggen/havbruksskatteutvalget-foresl%C3%A5r-40-grunnrenteskatt

Ragab, M., & Arisha, A. (2018). *Research Methodology in Business: A Starter's Guide*. Retrieved from

Ricardo, D. (1821). *On the principles of political economy and taxation* (3 ed.): Batoche books.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (Vol. 5).

Seafood Norway. (2017). Nurturing growth: the Norwegian Way. Accessed from https://sjomatnorge.no/wp-content/uploads/2014/04/SFN_Aquaculture_DontPrint.pdf

Sjømat Norge. (2020). *Høringssvar - NOU 2019: 18 Skattlegging av havbruk*. Retrieved from https://sjomatnorge.no/wp-content/uploads/2020/02/Sj%C3%B8mat-Norge-H%C3%B8ringssvar-NOU-Havbruksskatt.pdf

Skatteetaten. (2019). Petroleumsskatt på 147 milliarder kroner for 2018. Accessed from https://www.skatteetaten.no/presse/nyhetsrommet/petroleumsskatt-pa-147-milliarder-kroner-for-2018/

Statistics Norway. (2020). Konsumprisindeksen. Accessed from https://www.ssb.no/kpi

Statistisk sentralbyrå. (2019a). Export of salmon (Price per kg). Accessed from https://www.ssb.no/en/statbank/table/03024/chartViewLine/?loadedQueryId=10032499&timeType=top&timeValue=1050

Statistisk sentralbyrå. (2019b). Exports of salmon. Accessed from https://www.ssb.no/en/statbank/table/07681/chartViewLine/?loadedQueryId=10032496&timeType=top&timeValue=46

Vennemo, H., & Bjerkmann, I. L. (2018). *Grunnrente og grunnrentebeskatning i havbruk*. Retrieved from Vista analyse: https://vista-analyse.no/site/assets/files/6517/va-rapport_2018-26_grunnrente_og_grunnrenteskatt_havbruk.pdf