Salmon trout,

the forgotten cousin?

Ursula Landazuri[a]

Atle Oglend[a]

Marie Steen[b]

Hans-Martin Straume[c]

[a]Department of Industrial Economics, University of Stavanger, Stavanger, Norway

[b]School of Economics and Business, Norwegian University of Life Sciences, Ås, Norway

[c]BI Norwegian Business School, Department of Economics, Bergen, Norway

Abstract

This study investigates potential economic reasons why production of trout is maintained in Norway by analyzing prices and production for Norwegian Atlantic salmon and trout. The species Atlantic salmon dominates the global salmon market, but its two largest producers, Norway and Chile also farm in sea pens significant quantities of large rainbow trout (as opposed to portion-sized Rainbow trout farmed in fresh waters in other parts of the World, e.g., Iran, Peru, Turkey and others). Suggesting that this trout have some attributes that makes it a useful complement to Atlantic salmon. We investigate development in supply volumes of these species and conduct a cointegration analysis using monthly prices from 2000 to 2018. The results show that the markets for fresh and frozen rainbow trout are tightly integrated with fresh Atlantic salmon, and, where the latter is a price leader. This means that many consumers consider the two products as substitutes, with no clear preferences. There are no apparent productivity argument for the continued production of rainbow trout vis-à-vis Atlantic salmon. However, there may exist a fringe of consumers that prefer its characteristics, motivating firms to maintain its production as a means of diversification.

Keywords: Salmon, trout, aquaculture

1. Introduction

Salmon is among the most successful aquaculture species globally in terms of production growth, and it is the second most valuable group of aquaculture species after shrimp (Anderson et al., 2018; 2019; Garlock et al., 2020). Most studies of the salmon market focus on Atlantic salmon, which has become the leading species by quantity produced, largely overlooking that a number of other salmonids are also farmed, although in smaller quantities. These includes rainbow trout, coho, chinook and arctic char. Somewhat surprisingly, the two largest producers of Atlantic salmon, Norway and Chile, are also producing significant quantities of large rainbow trout, suggesting that this trout have some attributes that makes it a useful complement to Atlantic salmon. In this paper we will analyze prices and production for Norwegian Atlantic salmon and trout to investigate potential economic reasons for why production of trout is maintained. Specifically, we explore different hypotheses of why salmon trout remains competitive vis-à-vis Atlantic salmon relating chiefly to two factors: production cost and product differentiation.

With the exception of rainbow trout, the farmed salmon species all have in common with Atlantic salmon that they are farmed in relatively few countries. Rainbow trout is an exception in that it is farmed in two very different production systems, and in a large number of countries. Together with a few other countries, such as Chile and Finland, Norway produce the rainbow trout in salt water in net pens similar to Atlantic salmon, giving a fish that is harvested at similar weights (about 5 kg) as Atlantic salmon, and with red flesh. This contrasts strongly with the freshwater pond reared, white fleshed portion sized trout that are produced in most other countries.[1] As a result, the large red trout is often known as salmon trout. In the following, the

[1] Portion sized trout is harvested at between 0.5kg and 1kg and are referred to as portion sized since it tends to be cooked whole.

term salmon trout (or only trout) will be used when we refer to the large rainbow reared in saltwater pens.

In the next section we discuss some if the relations and differences between Atlantic salmon and salmon trout as a background for hypotheses. Then Section 3 turns to the global production of salmonid species before we turn to the market integration analysis in Section 4. In Section 4 the Norwegian export data on Atlantic salmon and salmon trout are presented and the empirical framework for the cointegration analysis are revised. The final subsection in market integration analysis presents the empirical results. A discussion of specific markets for salmon trout follows in Section 5, before ending with concluding remarks in Section 6,

2. Background

Nielsen et al. (2007; 2011) show that the white fleshed portion sized rainbow trout is not a part of what is normally referred to as the salmon market, but rather is on the fringe of the whitefish market. This separation with the salmon market contrasts the case of the larger sized salmon trout since Virtanen et al. (2005) indicates that the salmon trout, at least in Finland, is a close substitute to Atlantic salmon. Tveteras and Asche (2008) show that there is a well-integrated market for what they label as the red fleshed salmons in Japan, i.e. farmed coho and salmon trout and wild sockeye. These species are distinguishable from Atlantic salmon by their redder flesh. This provides one market argument for the production of salmon trout in that its color is closer to the wild Pacific species that traditionally dominated the Japanese market. Alfnes et al. (2006) and Forsberg and Guttormsen (2006) discuss how different markets have varying preferences for the color of the salmon flesh. Japan prefer the reddest color, while in several European markets there is a lower willingness to pay among consumer for the reddest salmon.

Hence, flesh color is a product attribute influencing consumer preferences and which accordingly can be used to target specific market segments.

Why some Norwegian farmers choose to farm salmon trout instead of, or in addition to, Atlantic salmon can be linked to different market-based economic hypotheses that broadly speaking relate to costs and differentiation. The discussion with respect to flesh color provides one such hypothesis related to differentiation, in that a redder flesh color can make the species particularly suitable in some specific markets, allowing the salmon trout to segment itself away from Atlantic salmon. There may also be other factors contributing either to a price premium or to less volatility. An important feature of the salmon trout production compared to Atlantic salmon is that a much higher share is shipped as frozen, a feature that follows from a stronger biological growth cycle, which may limit which market segment can be targeted. Asche and Bjørndal (2011) argue that one of the main advantages of Atlantic salmon is that it grows more evenly over the year than other salmon species, making it economically feasible to harvest the fish year around and therefore primarily serve the fresh market which tend to be the most profitable market segment for any species. This is also important since it also is allowing for more consistent marketing efforts, better capacity utilization in logistics and distribution as well as better coordination (Asche, Roll and Tveteras, 2007; Kvaløy and Tveteras, 2008; Olson and Criddle, 2008; Asche, Cojocaru and Roth, 2018).

Other economic aspects and biological factors that directly or indirectly influence production cost will not be a part of the scope of this paper. There is a large literature on productivity growth and cost development in Norwegian salmon aquaculture (e.g. Rocha-Aponte and Tveteras, 2019; Roll, 2019; Iversen et al., 2020) and environmental impacts (Tveteras, 2002; Pincinato, Asche and Roll, 2020). Trout production is included in the data sets analyzed in these studies, but it is not possible to separate salmon trout from Atlantic salmon production as their joint output is reported as an aggregate. Pincinato et al. (2020) show that there is no systematic variation in production losses between Atlantic salmon and salmon trout, indicating that the trout is neither more nor less suspectable to disease.[2]

3. Salmon production

In 2017, global production of rainbow trout (i.e., both portion sized rainbow trout and salmon trout) was over 751,652 thousand metric tons (mt), of which 147,453 mt took place in Chile, Finland and Norway.[3] Hence, the production of salmon trout was 147,453 mt in 2017, and this is the part of the rainbow trout production that will be counted as a part of the global salmon production in this paper due to its market position. Chile was the largest producer with 76,971 mt followed by Norway with 66,902 mt. Hence, the production of salmon trout is dominated by two countries, with Chile as the largest producer in recent decades.

Figure 1 shows global salmon production by species. The figure shows how total production has been rapidly increasing during the past decades. Moreover, the figure shows that even if Atlantic salmon is the dominant species, there is significant production of salmon trout and coho, in addition to a small production of chinook and other species that are too small to be considered. In 2017 total production was 2.7 million mt, Atlantic salmon made up 86.4%. Salmon trout made up 5.8% of the total production with 147.5 thousand mt, and 2000 was the first year since 1992 that coho production, with a quantity of 199.6 thousand mt, exceeded that of salmon trout production. The relegation of salmon trout to a third place in terms of volume

[2] We do not have data to directly assess growth performance, feeding efficiency or other factors that may impact production. The results of Weihe et al. (2019) indicate that even feeding strategy may matter.
[3] In the 1980s, Finland also produced portion sized trout, but this is excluded here based on estimates from Kontali Analyse. Portion sized trout is the largest aquaculture species in a number of European countries (Guillen et al., 2019; Llorente et al., 2020).

is largely due to a rapid increase in Chinese coho production that has allowed them to overtake Japan as the second largest coho producer, but Chile is by far still the largest producer of coho.

Figure 1 here

The dominance of Atlantic salmon in the global salmon market is relatively recent as can be seen from Figure 2, where the production shares of the four species are shown. In fact, in 1980 production of salmon trout was larger than the production of Atlantic salmon. With a quantity of 5.6 thousand tonnes salmon trout made up 45.8% of total production, while the share of Atlantic salmon was 39.0%. Norway, which at that time was the largest producer of both salmon trout and Atlantic salmon, had acquired know-how of aquaculture technology from salmon trout production and it was this knowledge combined with innovations in sea pens that was the foundation for the creation of the salmon farming industry (Nielsen et al., 2016). Japan largely developed coho farming independently and was the largest producer of coho.

In the 1980s the production share of Atlantic salmon increased rapidly to over 70%, a level where it was relatively stable until 2010 when it started to increase again and it has been around 85% in the last few years. During this period, the production share of salmon trout fell rapidly, and before 2017, 1990 was the year with the lowest production share. Hence, salmon trout also lost share to coho and even chinook. During this period Finland took over as the largest producer of salmon trout. In the early 1990s the production share of salmon trout increased again, particularly due to increased production in Chile who overtook Finland as the largest producer in 1994. Production was also increasing in Norway, who overtook Finland as the second largest producer in 1997. The Finnish salmon trout industry receded due to its membership of the

European Union which exposed it to increasing competition from Norwegian salmon in an increasingly globalized salmon market (Virtanen et al., 2005).

In Figure 3, Norwegian production of salmon is shown. Also here Atlantic salmon dominates, but also in Norway this is a recent phenomenon in that the production share of salmon trout was as high as 46.9% in 1980.[4] Production remained stable at around 5,000 mt in the 1980s. It declined to as little as 2.2% in 1990 as production was reduced to 3,796 mt before it rebounded. Production of salmon trout increased to 77 thousand mt in and a production share of 14.8% in 2002, the highest in the 2000s. Since then production has varied between 54 and 87.8 thousand mt around a stable mean. The highest production level, 87.8 thousand mt was reached as late as 2016.

While the production of salmon trout is moderate compared to salmon, it is still important in a Norwegian seafood sector dominated by salmon. On the top 10 list of exported products in 2016, there are 4 salmon products with fresh salmon and fresh salmon fillets occupying the two top spots (Straume et al, 2020). Whole fresh trout occupies the 10th spot and whole frozen trout the 16th spot.

Figure 2 here

Figure 3 here

[4] Salmon trout is regulated together with salmon in Norway, and producers are free to chose which of the species to produce (Asche and Bjørndal, 2011). Hence, there are no regulatory advantages associated with the production of salmon trout, and there do not appear to be any environmental advantages either (Tveteras, 2002; Torrissen et al., 2011; Abate et al., 2018).

4. Market integration analysis

One way to analyze if salmon trout is a differentiated product would be to survey consumers in different markets about the relative preferences for the attributes of Atlantic salmon and salmon trout, respectively. This data collection approach was out of scope for this investigation. However, another approach is to use the information contained in prices. By conducting a market integration analysis, the relative price movements between Atlantic salmon and salmon trout can tell us whether the two products are likely to be close substitutes. If they are close substitutes, salmon trout cannot be judged as a (strongly) differentiated product. To test this hypothesis, a market integration analysis is conducted for the two most important product forms of salmon trout and whole Atlantic salmon.

4.1 Data

The market integration analysis is based on monthly Norwegian exports of Atlantic salmon and salmon trout products from January 2000 through December 2018. Export prices of fresh and frozen whole salmon trout together with fresh whole Atlantic salmon are shown in Figure 4. The reason why no other Atlantic salmon product than fresh whole was included is because this product dominates Norwegian exports of Atlantic salmon, accounting for over 80% of the exports. Only a marginal share is exported as frozen salmon, as fresh fillets is the second most important product. This made it less relevant, e.g., to compare the export prices of frozen salmon trout with frozen Atlantic salmon. As can be seen from Figure 4, the prices appear to be highly correlated. This gives a clear indication that these prices share a common price determination process.

Figure 4 here

Table 1 shows descriptive statistics. There is not much differences in the mean price levels of the three prices. The two trout prices have a slightly higher price level than fresh salmon, but the difference is not statistically significant and is small enough to not create any strong price incentives for producing trout. However, the premium is high enough to justify a slightly higher production cost if that is the case.[5][6] It is also of interest to note that the price of fresh trout is higher than the frozen trout price despite the labor and energy that goes into the freezing process, supporting the notion that the ability to supply of fresh fish gives the highest value to the producer (Roheim et al, 2007). The coefficient of variation is the same for fresh whole trout and fresh salmon, and slightly higher for the storable product frozen trout. This is most likely due to the differences in perishability. Hence, trout appear to have neither an advantage nor a disadvantage relatively to salmon with respect to price risk.[7]

Table 1 here

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[5] The Directorate of Fisheries does not break down their production cost data by species, and there is accordingly no information available with respect to the production cost for trout relatively to salmon. However, this do suggest together with the common price development that the same factors that has led to productivity growth for aquaculture in general and salmon in particular (Asche, 2008; Kumar and Engle, 2016; Anderson et al., 2019) also have impacted salmon trout.

[6] There is a rapidly increasing literature on sustainable seafood indicating that producers with production labeled to be sustainable obtains a price premium that has an increasing impact also on aquaculture (Roheim et al., 2018; Sogn-Grundvåg et al., 2019; Tlusty et al., 2019; Osmundsen et al., 2020; Osmundsen, Olsen and Thorvaldsen, 2020). Alfnes et al. (2018) indicate that there are 48 different sustainability labels in use for salmon, and Bronnmann and Asche (2017) show that the generally negative consumer perception of farmed fish relatively to wild can be made up with an ecolabel. However, salmon trout has received little attention in the respect, and this does not seem to be a potential explanation for the limited premium. Asche et al. (2015) and Ankamah-Yeboah et al. (2016; 2020) show that there a significant premium associated with organic labeled salmon, a fish that is significantly more expensive to produce, suggesting that the moderate premium may be associated with higher production costs.

[7] This also implies that the Fishpool exchange (Asche, Misund and Oglend, 2016; Misund and Asche, 2016; Ankamah-Yeboah et al., 2017; Oglend and Straume, 2020) can be used equally well for salmon trout as for salmon. It is also worthwhile to note that while fish price volatility in general is high (Dahl and Oglend, 2014; Asche, Dahl and Steen, 2015), salmon and thereby by implication salmon trout are among the less volatile fish prices. A consequence is also that salmon trout production has most likely been as profitable on a per unit basis as salmon (Misund and Nygård, 2018).

Figure 4 also indicates that there is no clear seasonality in the prices, a feature that is well known for the salmon price (Asche and Guttormsen, 2001), even though there is seasonality in production cost (Asche, Oglend and Kleppe, 2017). There is seasonality in the harvesting (Asche, Oglend and Zhang, 2015), a feature which is largely demand driven with a clear peak around Christmas, but as it is expected, it does not show up in the prices.[8] The seasonality in the exports is very similar for fresh salmon trout to what is the case for fresh salmon. The seasonal pattern is stronger for frozen salmon trout, this also aligns with what one can observe for frozen salmon, and shows that the storable product follows the cycle in production cost more closely. The fact that the seasonal patterns for salmon trout does not deviate to any extent from Atlantic salmon indicates that this is not a margin where there exist additional premiums. or costs, for salmon trout.

4.2 Market integration

The basic relationship to be investigated in a market integration study is (Asche, Bremnes and Wessells, 1999):

$$lnP_{1,t} = \hat{\alpha} + \hat{\beta} lnP_{2,t} + e_t, \tag{1}$$

where $P_{1,t}$ and $P_{2,t}$ are the prices of two different goods at time *t*, 1 and 2. The parameter α is a constant term that captures transportation cost and/or quality differences. Other factors that influence price are assumed random with expectation zero and are captured in the error term, e_t. The main interest is related to the parameter $\hat{\beta}$. Perfect or full market integration implies that $\hat{\beta} = 1$, so that the two prices moves proportionally over time. This is often labeled as the

[8] The seasonality is still moderate compared to what is the case in most fisheries as descrbed in the case of Norwegian fisheries by e.g. Bertheussen and Dreyer (2019) and Birkenback et al. (2020). This is most likely also causing aquaculture to have lower production risk than fisheries (Asche et al., 2020b).

Law of One Price (LOP). On the other hand, if $\hat{\beta} = 0$ there is no relationship between the prices and the price determination process for the two products are independent. If $0 < \hat{\beta} < 1$, there is a relationship between the prices indicating that the two prices influence each other, but not completely. Hence, there is market integration, but this is incomplete or alternatively, the two products are imperfect substitutes.

OLS regression requires that the probability distribution of each variable in the regression remain stationary over time, which can be translated into requirements of a constant mean, variance, and covariance. Since most price variables in economics are nonstationary in levels, estimating equations without any transformation or augmentation is not advisable. Taking the first-difference of the price variables will often lead to stationarity. Several tests can be used to evaluate if a series is nonstationary, but the augmented Dickey-Fuller (ADF) test, and generalized least squares Dickey-Fuller (glsDF) tests, are commonly used (Elliott et al., 1996; Gordon, 1995). The ADF is a test of the null hypothesis that the price series is stationary in first-differences, with the alternative hypothesis stationary in levels. The glsDF differs from the traditional DF test by a transformation based on a generalized least squares procedure before the DF test. A distinction between the two tests is that the glsDF has more power to detect near stationary series.

Even if non-stationarity price series violates distributional conditions of traditional regression analysis, one can still estimate equation (1) if the relationship between the two prices can be modelled in a way that makes the error term stationary; in this case, the prices are said to be cointegrated meaning they form a long-run relationship. Engle and Granger (1987) suggested to estimate equation (1) using OLS, and test if the resulting errors were stationarity. However, this procedure ignores the endogeneity issues that characterizes many cointegration relationships, namely, that influence between prices go both ways. An approach that avoids the endogeneity issue is the Johansen cointegration procedure (Johansen 1988; 1991). This procedure uses a vector autoregressive estimation framework where all the included variables initially are treated as endogenous. Moreover, this framework allows hypothesis testing such as if the LOP holds or if any of the price variables are weakly exogenous. As noted above, a test for the LOP entails a test of the null hypothesis that $\hat{\beta} = 1$. The exogeneity test is a test of whether a variable is determined outside the system in question, and therefore if it leads the other prices.

Another advantage of the Johansen procedure is that it can handle a multivariate system of non-stationary variables (Johansen, 1988). Testing cointegrating relationships are therefore not constrained to bivariate cases as described by equation 1. The estimated equations contain both the long-run parameters that correspond to equation 1 (i.e., cointegration) and short-run parameters that can be interpreted as the speed of adjustment to the long-run equilibrium relationship. In a multivariate market integration setting, all prices must share the same stochastic trend to have a common price determination process. In a system with n prices, this implies the existence of n-1 cointegration vectors (Asche, Bremnes and Wessells, 1999).

In the Johansen framework, test of co-integration in the Johansen framework, the max test and the trace test, are based on the eigenvalues of the maximum-likelihood estimation (Johansen and Juselius, 1991). The two tests have the null hypothesis that there are a maximum k cointegration vectors. They differ in the alternative hypothesis, where the max tests for more than k cointegration vectors, while the trace tests if there are $k + 1$ cointegration vectors.

4.3 Empirical results

The first step in the analysis is to determine the time series properties of the price series. In particular, one is interested in testing whether the series are stationary or not. For the log of the levels of the three prices series, the null hypothesis of a unit root is not rejected for neither the more conventional ADF test or for the glsDF test, which has more power to reject the null.

However, the null of a unit root is firmly rejected for all the three prices after they have been differenced, in the column to the far right in the table. This suggest that all the prices are nonstationary and containing one unit root, which makes the cointegration procedure appropriate for analyzing market integration. This is not surprising as this is what is commonly reported for salmon prices (Tveteras and Asche, 2008: Nielsen et al, 201; Asche et al., 2014; Landazuri-Tveteras et al., 2018).

Table 2 here

Given that the prices are first difference stationary, the next step is to analyze whether there exists cointegrating relationships between the series. It is common to start with bivariate tests of cointegration. Since there are three price series it is sufficient to run two bivariate cointegration tests where the fresh salmon price is used in both. These are reported in Table 3 together with tests of the LOP hypothesis and of weak exogeneity.

The first test is the relationship between fresh whole salmon trout and fresh whole salmon. Both the trace and max test reject that null hypothesis that there are zero cointegrating vectors. Moreover, the trace test does not reject the null of one cointegrating vector, while the max test keeps the null that there are at least one cointegrating vector. This supports that the relationship between the two prices is stationary and, consequently, that they are cointegrated sharing the same stochastic trend. The test of the LOP give further evidence of strong market integration, as the null of fully integrated markets (i.e., that $\hat{\beta} = 1$ in equation 1) cannot rejected. The test of weak exogeneity is rejected for the fresh whole trout price at the 5 percent level, but not for fresh whole salmon. Hence, Atlantic salmon is the price leader in this relationship.

The bivariate test between frozen trout and fresh salmon mirrors the results from that between fresh trout and fresh salmon; the trace and max tests suggest there is one cointegrating vector and the LOP hypothesis cannot be rejected, and again, the tests of weak exogeneity suggests salmon is the price leader.

While the market integration relationships are not influenced by the tests only being bivariate, the weak exogenity can be influenced. A multivariate test with all three prices is therefore also conducted and reported in the last three rows of Table 3. The results confirm the findings as the cointegration tests show evidence of two cointegrating vectors. The tests of weak exogeneity indicate that the prices of fresh and frozen trout are endogenous in the system, while the salmon price is weakly exogenous. In other words, salmon is the price leader and the LOP cannot be rejected. Hence, salmon trout is well integrated into the salmon market, and there is no evidence of differentiation. The results are similar to what has been found for wild salmon in relation to farmed Atlantic salmon (Asche, Bremnes and Wessels, 1999) and Chilean salmon in relation to Norwegian salmon (Asche, Cojocaru and Sikveland, 2018) in that the market is highly integrated, and the price of Norwegian Atlantic salmon lead the market.

Table 3 here

5. Targeting specific markets

The red color of the salmon trout flesh is an attribute that was important in the 1990s. The expansion in the Norwegian production (and similar in Chilean production) corresponds to a period when farmed salmon largely took over the Japanese salmon market from wild salmon from Alaska (Tveteras and Asche, 2008). In year 2000 as much as 95.4% of the Norwegian salmon trout exports was whole frozen. Most of it was shipped to Japan, although Russia had started to become an important market in the late 1990s.

In Figure 5, the Norwegian exports of the three most important product forms of salmon trout is shown. As one can see, two product forms dominate, fresh whole and frozen whole, the third is fresh fillets which has never had an export share higher than 5.5%. The most notable feature is the significant shift in export share from whole frozen which dominated in 2000 towards whole fresh. By 2018 whole fresh is by far the most important product, with an export share of 73.4%, while the share for whole frozen is down to 22%. Initially, this shift was incentivized by increased demand from Russia, where there in some setting also where a strong preference for red fleshed salmon. An import stop to Russia for a period in 2006 is clearly visible as a shift back to frozen as exporters was scrambling to find new markets, and although the exports to Russia of fresh recovered somewhat, they completely stopped with the trade embargos following the Russian invasion of Crimea in 2014. The fresh salmon trout was in the 2010s largely diverted to the EU, which now constitutes the main market. As this is the main market also for the Norwegian Atlantic salmon, the red flesh and the market opportunities it provided in first Japan and then Russia was important for the production expansion in the 1990s and possibly the early 2000s, but it has little relevance now. Hence, there do not appear to be specific product attributes that gives the salmon trout any advantage in any specific markets any longer.

Figure 5 here

6. Concluding remarks

The two largest producing countries of salmon, Norway and Chile, both maintain a significant production of a second species, salmon trout. This paper has investigated potential reasons for this segmentation in Norway, and the conclusion is largely negative in that there appear to be no apparent market reasons. Currently, salmon trout is well-integrated into the lager salmon market, with the LOP holding and the price of Atlantic salmon determining the price for salmon trout. Price volatility is similar, as are seasonal patterns. The redder flesh appears to be the main reason why production of salmon trout increased rapidly in the 1990s primarily targeting the Japanese market. However, with a weaker Japanese market, most salmon trout now go to the main market for Atlantic salmon, the EU, and there do not appear to be any markets with a clear preference for the redder fleshed fish.

There is a small price premium for salmon trout relatively to Atlantic salmon. However, this does not appear to cover additional cost since the salmon trout has been losing market share to Atlantic salmon. Hence, most farmers appear to prefer Atlantic salmon. However, the disadvantage with producing salmon trout does not appear to be large, given that the production level is maintained even in this environment.

With no clear economic reasons for why farmers are producing salmon trout, it is likely to maintain a precarious position. Production was going down in the late 1980s until the Japanese preference for red-fleshed salmon opened that market. That is a pattern that may well be repeated if one cannot find new market segments with a clear preference for salmon trout. This is a risk that may be exacerbated by new production technologies in salmon aquaculture such as land-based farming (Bjørndal and Tusvik, 2019), which does not seem to be applied to production of salmon trout. On the other hand, disease risk appears to be an increasingly important factor in salmon production. Oglend and Tveteras (2009) argue that geographical diversification is a potential tool. Diversification may also be relevant since salmon producers tend to export to many different markets (Straume, Landazuri-Tveteraas, Oglend, 2020), so that even small differences in taste preferences among markets may give rise to marketing opportunities for salmon trout. Hence, species diversification can be another tool, and that may give salmon trout a continued role in the future.

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