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Demand Growth for Atlantic Salmon: The EU and French Markets

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Abstract *Two main factors have determined the development for successful aquaculture species—productivity growth and demand growth. However, while we have substantial knowledge of productivity growth, our insights are more limited for demand growth. In this article we investigate the demand growth for salmon in the EU and France using an index approach. Depending on exogeneity assumptions, the measure of demand growth will be either price or quantity oriented. The results indicate that demand growth has been substantial as it is 7.6% per year for the EU and 4.7% for France, on average. The demand growth is anything but smooth over time though, as there are several periods with negative demand growth as well as periods with substantially higher demand growth.*

Key words Demand growth, salmon, EU, France.

JEL Classification Codes D12, Q22.

Introduction

Over the last few decades, aquaculture has been the world's fastest growing food production technology (FAO 2006). From an economic perspective, two factors have driven this development; productivity growth and demand growth (Asche 2008; Asche and Bjørndal 2010). The effect of productivity growth is well understood, as control with the production process enables innovations to increase productivity, reduce production cost, and increase competitiveness (Anderson 2002; Asche 2008; Valderrama and Anderson 2010).

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Productivity growth has allowed increased profitability in the production process and lower prices to consumers (Asche and Bjørndal 2010).

There is a large methodological literature with respect to how productivity growth is measured. Empirically, technical change can be measured as continuous and smooth using trend proxies or as highly discrete changes measured using dummy variables or indices (Kumbhakar and Lovell 2000). A number of productivity studies have been carried out for different fish species, with salmon as the most studied. Some recent examples are Tveteras (2002); Guttormsen (2002); Sharma and Leung (2003); Kumbhakar and Tveteras (2003); Gordon *et al.* (2008); Asche, Roll, and Tveteras (2009); Gordon and Bjørndal (2009); Nilsen (2010); and Vassdal and Sørensen Holst (2011).

Substantially less is known about demand growth. Asche, Bjørndal, and Young (2001); Asche, Roll, and Tveteras (2007); and Asche (2008) highlight the importance of demand growth in geographical as well as product space and more efficient logistics using salmon and shrimp as examples where these have been important driving factors. Roheim, Gardiner, and Asche (2007); Roheim (2009); and Ropicki, Larkin, and Adams (2010) provide examples of how non-market factors can influence demand. Asche, Roll, and Trollvik (2009) also point out that species in which the price development indicates substantial productivity growth will have limited production growth if there is no demand growth. Sea bass and sea bream in the Mediterranean are examples of species where the price decline has been as rapid as for salmon, but where production growth is less than a tenth of the growth for salmon. The main reason seems to be that the geographical market has not been expanded beyond southern Europe, and there has been little product development as virtually all consumer product is still sold in one form, portion sized fresh fish.

The methodological framework for investigating demand growth is less sophisticated than for productivity analysis. Deaton and Muellbauer (1980) suggest that a smooth time trend can be interpreted as a shift in consumer preferences. This approach is commonly used in empirical work on net demand growth. In addition, Kinnucan *et al.* (1997) point out that several aggregate indicators measuring shifts in consumer preferences are used in the literature, including marketing expenditures, health indicators, and media coverage. However, these indicators also tend to be relatively smooth. Examples of the use of such preference variables can be found in Bjørndal, Salvanes, and Andreassen (1992); Kinnucan and Miao (1999); and Kinnucan and Myrland (2006, 2007).

In this article we use a recent approach due to Marsh (2003), which allows demand growth to vary independently between years. The approach is based on the construction of an index that is derived by comparing actual price change with the change that one would expect with a given demand elasticity and the actual quantity change, denoting the difference as demand growth. The approach of Marsh (2003) assumes that quantity is exogenously determined. This can be reformulated to also account for the case where price is assumed exogenous, allowing for quantity-oriented as well as price-oriented measures of demand growth. This is conceptually similar to the input and output orientation of efficiency measures in the production efficiency literature (Kumbhakar and Lovell 2000).

We apply the method to the market for salmon in France and the EU. The European market for salmon is interesting because of the substantial development that has occurred in the last few decades. Production of Atlantic salmon has more than doubled, from less than 700,000 tonnes in 1998 to almost 1.5 million tonnes in 2010. As productivity and demand growth both constitute important factors in this market, it is an excellent market in which to study the impact of demand growth. To support this argument, figure 1 shows aggregate production of Atlantic salmon together with the real Norwegian export price.[1] The figure shows that up to the mid-1990s, productivity growth clearly outpaced

[1] As the global salmon market is well integrated and Norway is the largest producer, this should give a good representation of global price (Asche and Bjørndal 2011).

demand growth, resulting in a significant downward shift in the real price. However, from the mid-1990s onward, the real price has been relatively stable; indicating that demand growth has kept pace with productivity growth. With the increased salmon production, this suggests substantial demand growth.

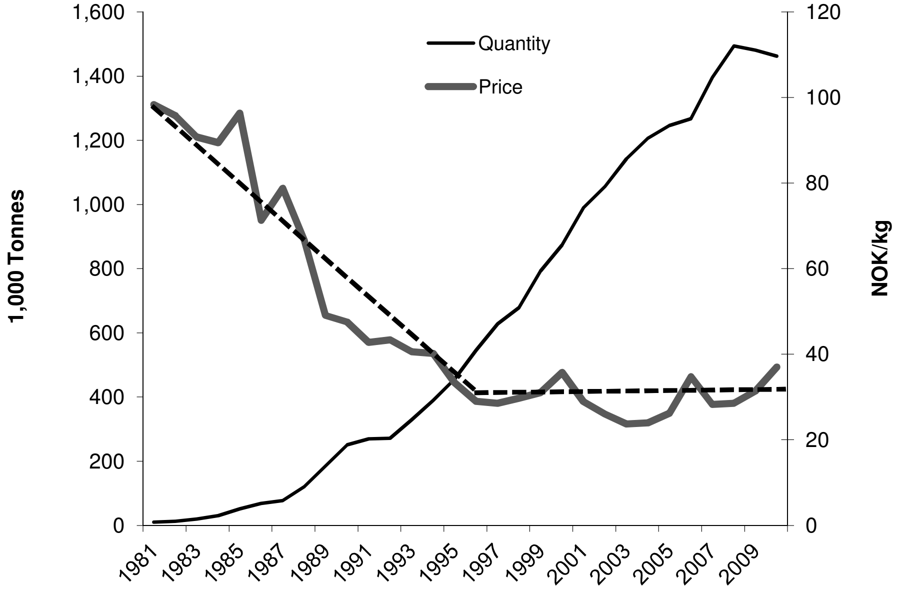

Figure 1. Global Production of Atlantic Salmon and Real Norwegian Export Price 1981–2010 (2010=100)

Source: Kontali Analyse; Norwegian Seafood Export Council.

Theory and Method

Most demand studies assume price to be exogenously given, either because the demanded quantity considered is so small relative to the aggregate market that it cannot influence price or because price is determined by marginal cost in a competitive industry. On the other hand, when investigating seafood markets, it is common to model quantity variables as exogenous variables based on the production fact that the catch of the day will be landed at the market independently of market conditions. Based on the assumptions imposed, demand growth can be measured either as a quantity shift or a price shift, as these factors will be the buyers' choice variables. If neither of these exogeneity assumptions hold, the slope of the supply schedule must be taken into account, as this will determine the new price quantity combination due to the shift in the demand schedule. This is done in very few studies, and it implies that most analysis of demand growth can be conducted without taking supply considerations into account.

The approach of Marsh (2003) implicitly assumes that price is the choice variable for buyers. Let gross demand growth be the shift in demand without accounting for other exogenous factors, such as changes in the price of substitutes or income. Gross demand growth can then be found as the difference in the price paid in period p_{t+1} and predicted price in period *t+1* given the demand elasticity, the quantity purchased, and the quantity actually purchased at the given price in period *t*.

More specifically, given a price series and quantities, the steps involved in computing demand growth from one period to the next is:

First, find the percentage quantity change:

$$\frac{q_{t+1} - q_t}{q_t} = \%\Delta Q. \tag{1}$$

Given the demand elasticity, η, find the expected price in period t+1 given that the demand schedule does not change:

$$P_t\left(1 + \frac{\%\Delta Q}{\eta}\right) = \hat{P}_{t+1}. \tag{2}$$

The percentage demand growth, D′, is then how the actual price shifts compared to the predicted price:

$$\frac{P_{t+1} - \hat{P}_{t+1}}{\hat{P}_{t+1}} = D'. \tag{3}$$

These computations provide the demand growth from period to period. If one normalizes the first (or any other observation) to one, one can construct an index showing the demand level over time (Marsh 2003).

Similarly, demand growth in the quantity dimension can be found by first observing the price change, and with a given elasticity, find the expected quantity change. The next step is to determine how much this deviates from the actual observed quantity. The expected quantity in the next period will be:

$$Q_t\left(1 + \frac{P_{t+1} - P_t}{P_t} / \eta\right) = \hat{Q}_{t+1}. \tag{4}$$

Demand growth is then:

$$\frac{Q_{t+1} - \hat{Q}_{t+1}}{\hat{Q}_{t+1}} = D'. \tag{5}$$

The price-oriented and quantity-oriented measures of demand growth will be identical if the elasticity is –1. Otherwise they will differ, with the price-oriented measure indicating higher (lower) demand growth if demand is elastic (inelastic).

We estimate gross market growth, but impose no money illusion (or account for the general price level) by deflating the prices. Net market growth can be found by purging the data series income and substitution effects. This can be done using the Frisch-Waugh theorem. However, it is well documented that there are few close substitutes to salmon (Asche, Bjørndal, and Young 2001; Jaffry *et al*. 2001; Asche, Gordon, and Hannesson

2002, 2004; Nielsen *et al.* 2007). Hence, the difference between the gross and the net effect is primarily income growth. With an income elasticity of around one and economic growth of 1–2% in the most important markets for salmon (EU, Japan, USA), the net demand growth will be 1–2% lower than the gross demand growth. We prefer to use the gross measure in this study, since what is most important for development of the industry and the producers is how much the demand schedule is moving in total.

As our interest is demand growth, the price will be measured in the domestic currency. However, in international supply chains the measure will be distorted by exchange rate changes from the exporters' perspective. In seafood supply chains, the impact of the exchange rate can substantial (Asche and Tveterås 2008; Xie, Kinnucan, and Myrland 2008).

Data

We investigate demand growth in two markets, France and the EU, at the import level. The EU is the largest market for farmed salmon in the world, making up more than 50% of total Atlantic salmon consumption (Asche and Bjørndal 2011). Within the EU, France is the largest and most sophisticated salmon market with the largest variety of product forms.

The data available for the analyses are import quantities and values of salmon to the EU and France, allowing us to compute unit prices. We use import data in empirical work for three reasons. First, most salmon is processed relatively close to the consumer. Imports are dominated by the category whole fresh salmon, and most other product forms have a relatively low processing level. This implies that the data series contain a relatively homogenous product. Second, virtually all demand studies in Europe have been carried out using trade data, and a great deal of what we know about demand elasticities is based on trade data.[2] Finally, the trade data is readily available over a number of years. We have not been able to obtain long data series of demand data at the consumer level in France, where they exist, and it is impossible for the EU in total.

Our data cover the period 1996–2009. To avoid short-term noise, we use annual data. The data for the EU is from Eurostat, and are the total EU-imports plus imports from Scotland and Ireland.[3] This is to avoid double counting by including the trade between different member countries. For France, we use the French import statistics. All data was made available by the Norwegian Seafood Export Council. The French data was deflated by the French consumer price index, and similarly the EU data was deflated by the EU consumer price index.

Empirical Results

We start the empirical analysis by investigating demand growth in the EU. In figure 2, we show aggregate import value, imported quantity in live weight equivalents, and unit price to the EU for the period 1996–2009. Over the period, the quantity imported has more than doubled, from 280 thousand tonnes to 634 thousand tonnes. A similar increase can be observed for the import value, which increased from four Euros with no apparent trend. This reflects stability in the Norwegian export price from the mid 1990s, as shown in figure 1, and as the import value is more variable than quantity, there are also substantial variations in price, with clear peaks in 2000 and 2006.

Virtually all studies of salmon demand assume price to be exogenous, and accordingly, that quantity is the importers' choice variable. This implies that a quantity-oriented

[2] Xie and Myrland (2011) is a recent exception.
[3] This gives a small bias, since Scottish production consumed in the UK is not accounted for.

measure of demand growth is appropriate in this case. Before demand growth can be computed, we must determine the appropriate demand elasticity. In the literature, a wide variety of estimates has been reported. However, in general, it is clear that aggregate demand for salmon seems to be elastic, and that the elasticity is approaching –1 as the increased supply leads to a shift down the demand schedule (Asche 1996; Xie, Kinnucan, and Myrland, 2009; Asche and Bjørndal 2011). In figure 3, we report demand growth for three different demand elasticities; –1, –1.2, and –1.4. As the demand growth is from one year to the next, the x-axis in the figure reports the years as a year change; *i.e.*, for the label 1997 the reported demand growth is from 1996 to 1997.

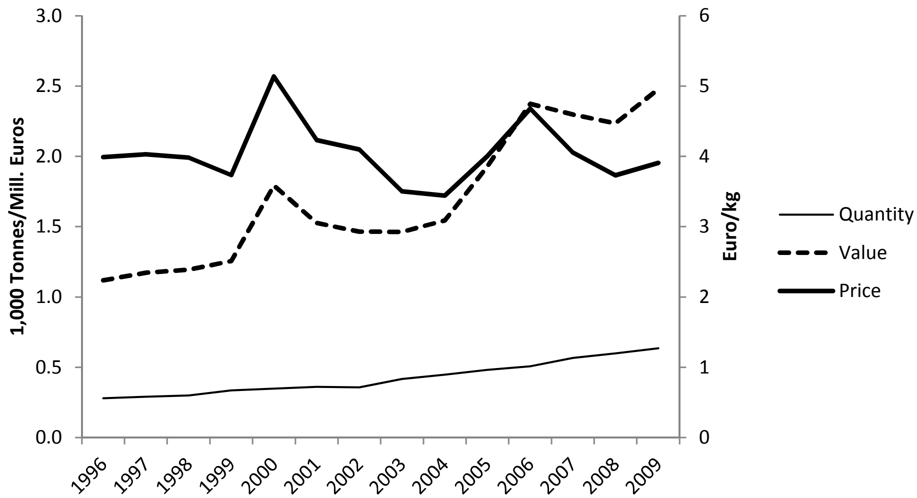

Figure 2. Imported Quantity, Real Value, and Unit Price (2009=100) for Salmon to the EU

Source: Eurostat.

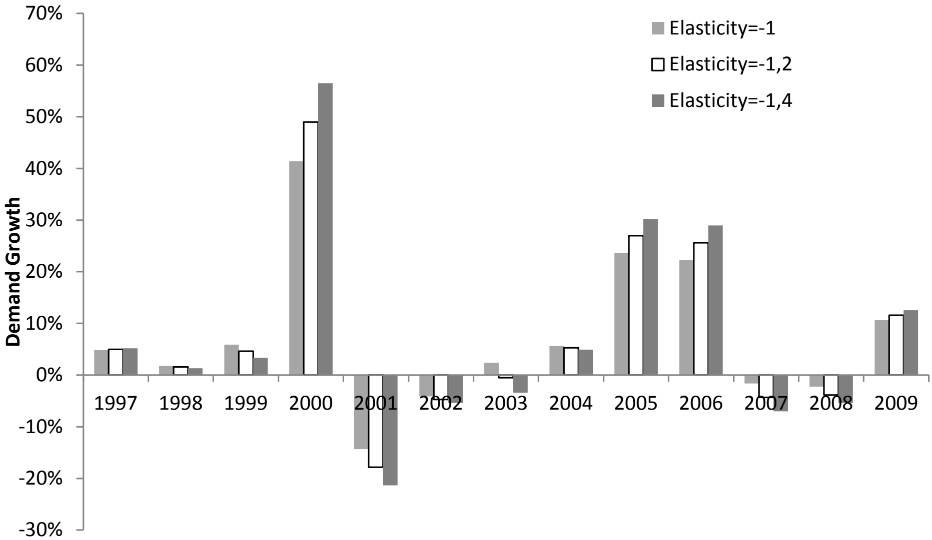

Figure 3. Demand Growth in the EU for All Salmon with Different Elasticities

The results reported in figure 3 indicate that the demand growth is highly variable over time, independent of elasticities. In four of the years, demand growth is negative for all elasticities, and in one year the quantity change is sufficiently large to make demand growth positive for the least elastic demand, but not for the two most elastic demand elasticities. In eight years the demand growth is positive. In total, this gives an average demand growth that varies little with the assumed elasticity, as it is 7.4% when the elasticity is –1 and it is 7.7% when the elasticity is –1.4. Given that quantity growth is relatively stable, it is not surprising that periods with the highest demand growth are associated with periods of large price increases, and that the following price adjustments are associated with periods where demand growth is negative. This is also consistent with the very inelastic short-run supply elasticity reported by Andersen, Roll, and Tveterås (2008).

The most important product form is fresh salmon. However, despite the increased product variety facing the consumer, the import share (in value) of fresh salmon remains relatively stable, slightly above 60%, with frozen fillets ranked the second most important product form. Hence, since the degree of processing for these products is limited, it is clear that most of the value-added processing that leads to product development and differentiated consumer products takes place within the EU. In figure 4 we show demand growth for fresh salmon. As one can see, its pattern is highly variable, and mostly along the same lines as for the EU in total. On average, demand growth is somewhat higher for fresh salmon than for all salmon. It is 8.7% with a demand elasticity of –1 and 9.1% with a demand elasticity of –1.4.

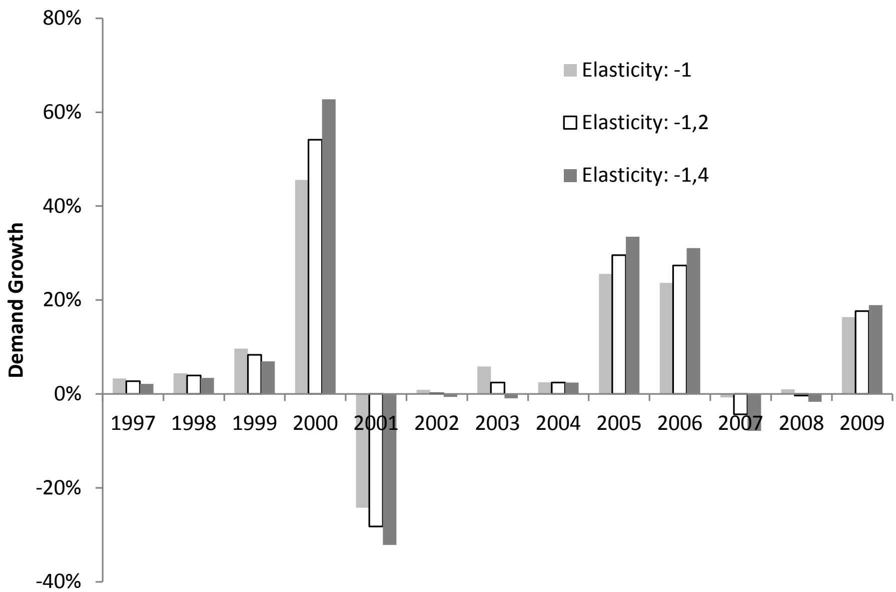

Figure 4. Demand Growth for Fresh Salmon in EU with Different Elasticities

We now turn to investigate the data set for France. France is the largest and arguably most sophisticated salmon market in the world. The results for the EU indicate that different elasticities within a reasonable range do not make much difference for our estimates of demand growth. Consequently, we will only report results for a demand elasticity of –1.2. These are reported in figure 5 for all salmon products as well as fresh salmon. Demand growth in France is highly variable with some years of very strong and very weak demand growth. It is also interesting to note that although the main pattern is similar to the EU, as one would expect given that an integrated market gives highly correlated prices, there are also clear differences. The most important difference, though, is the magnitude of the demand growth. In France it is 4.7% for all salmon and 4.3% for fresh salmon, on average. Hence, in contrast to the EU at large, fresh salmon is losing share, an indication that more salmon is being processed in other EU countries. This is not too surprising given that many of the new EU countries, in particular Poland, have seen the development of a substantial export-oriented salmon processing industry after they became members (Asche and Bjørndal 2011). This is largely due to the lower wage levels. The fact that demand growth in France is lower than in the EU in general also indicates that the relative importance of the French market is declining over time. It can also be interpreted as an indication that while product development allows a mature market to continue growing, it is still easier to expand market size by entering new markets.

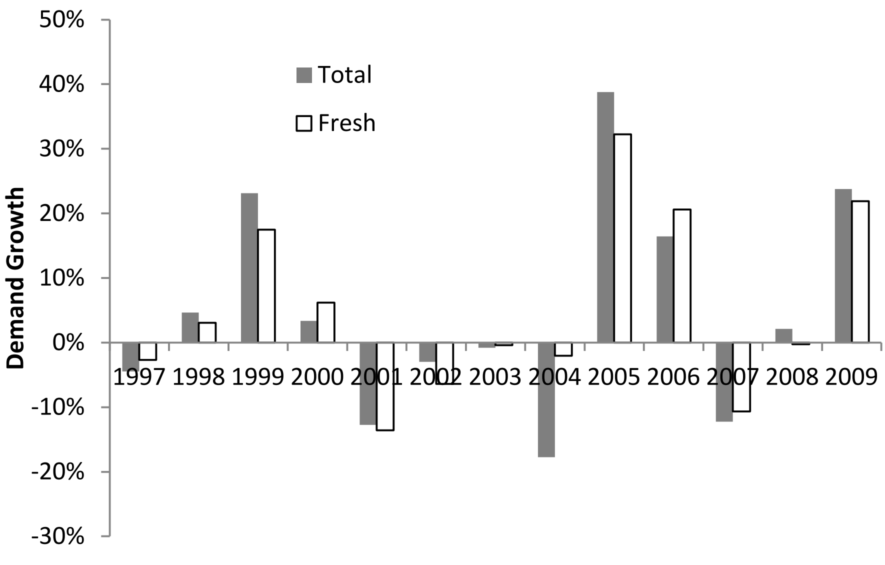

Figure 5. Demand Growth for Fresh and All Salmon in France

Concluding Remarks

One can observe that successful aquaculture species, like salmon and shrimp, have expanded their markets to be global and that they are marketed in an increasing number of product forms (Asche and Bjørndal 2010). For the aquaculture producers, this translates to aggregate demand growth, increasing the quantity that can be produced profitably at any price level. The importance of the demand growth can readily be illustrated by comparing salmon and shrimp production, both of which are at more than one million tonnes, with the production of sea bass and sea bream. These two species have experienced price declines at magnitudes similar to what has been observed for shrimp and salmon, indicating similar productivity growth. However, production has increased to just over 100,000 tonnes as demand has remained stable because it has not increased in geographical or product space.

Measuring demand growth has received substantially less attention than measuring productivity growth, and most approaches assume a relatively smooth process. The literature on technical change indicates that this can be a restrictive assumption, as technical change is often highly variable. Tveteras (2000) provides a good example for Norwegian salmon. In this article we use a recent approach by Marsh (2003) to compute demand growth, allowing it to be unstable. This is used to investigate demand growth for salmon in the EU as well as France.

Casual observation of the data (figure 1) indicates that demand growth has been important, as price has remained stable despite the fact that the quantity sold more than doubled between 1998 and 2008. The analysis confirms this interpretation, as demand growth for all salmon in the EU is 7.6% per year, while it is 4.7% for France, on average. Moreover, demand growth is anything but smooth over time, as there are several periods with negative demand growth as well as periods with substantially higher demand growth than these averages.

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