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Innovations and Structural Change in Seafood Markets and Production: Special Issue Introduction

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Introduction

A large and growing body of scientific research has documented the benefits of seafood in the human diet (Nesheim and Yaktine 2007; FAO/WHO 2011). A rising global awareness of the benefits of seafood, together with population growth, should lead to increased seafood demand in the future. Consumers will not only demand more seafood but also increased product quality and diversity as they become wealthier (Jensen 2006).

To satisfy the world's growing seafood demand, the seafood sector must innovate in many areas. Finite global resources in terms of wild fish stocks and available areas for aquaculture, together with substantial external environmental effects, provide significant innovation pressure on the sector. Despite local and global constraints due to environmental challenges and competing user interests, aquaculture has to provide most of the future growth in seafood production, since most of the world's fish stocks are fully exploited or over-exploited (Smith *et al*. 2010b). During the last few decades aquaculture has been the world's fastest growing food production technology, creating a blue revolution (Asche 2008). Furthermore, aquaculture is better positioned than fisheries to provide the product quality and diversity that future consumers will demand, as a higher degree of control with the production process facilitates innovation in both production processes and products (Anderson 2002; Asche 2008; Asche, Roll, and Tveteras 2009).

However, the fisheries sector must not be ignored as a future supplier of healthy, nutritious food and food diversity. Through innovation there is much scope in fisheries-based value chains to reduce supply cost and improve product quality and safety. An important source of innovation is the government regulations that provide constraints and

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incentives to fisheries-based value chains on fishing technology choices and fishing and distribution strategies (Sanchirico and Wilen 1999; Wilen 2000; Homans and Wilen 2005; Smith 2008; Kvaløy and Tveteras 2008; Asche, Bjørndal, and Gordon 2009; Fell 2009; Abbott, Garber-Yonts, and Wilen 2010; Valderrama and Anderson 2010).

Aquaculture faces many innovation opportunities, but also a number of challenges related to environmental sustainability, disease, and competing user interests (Tveteras 2002; Tveterås 2002; Asche, Roll, and Trollvik 2009; Tveterås and Tveteras 2010; Chu *et al*. 2010; Torrissen *et al*. 2011). These challenges represent constraints that may limit future growth rates, and in some cases even lead to a fall in production. The dramatic decline observed in production of some aquaculture species in some countries—shrimp in several Asian countries and salmon in Chile, for example—provide ample evidence of the challenges facing aquaculture (Anderson 2003; Asche *et al*. 2009).

The future innovations that both aquaculture and fisheries require to grow and be sustainable will often depend on sufficient investment in research and development (R&D). For several aquaculture species both the public and private sectors have invested in R&D. Often these investments have enabled radical innovations. An example is salmon aquaculture. Salmon feed, which represents over 50% of a farm's production costs, has evolved dramatically since the 1980s due to large investments in R&D. Formulation of salmon feed is now based on extensive knowledge of how different ingredients influence salmon growth and health and interact with each other (Forsberg and Guttormsen 2006). R&D has also played a significant role in disease management, where a number of targeted vaccines have been developed to combat various diseases. To some extent these have replaced curative medication, such as antibiotics. Salmon farming now uses much less antibiotics per kilo of meat produced than is the case in terrestrial meat production, such as pork and poultry.

Innovations in key technologies have contributed to a significant productivity growth in salmon farming, which again has made it possible to expand production. But in order to continue technological progress and further improve productivity, one has to ask how large will R&D investments have to be? Figure 1 shows inflation-adjusted production costs together with R&D intensity measured by R&D expenditures in percent of sales, and measured by R&D expenditures per kilo produced in Norwegian salmon aquaculture. Although total R&D investments have increased in salmon aquaculture, R&D intensity has declined due to a 600% increase in sales and an 800% increase in production volume. We see that the decline in R&D intensity is accompanied by stagnation in real production costs, which may be attributed to insufficient innovation rate (Nilsen 2010; Asche, Roll, and Tveteras 2011; Vassdal and Holst 2011). Hence, this figure may motivate a debate on whether insufficient investments in R&D have been a central source of a decline in productivity growth.

Now, it may not be necessary to maintain high R&D intensity as production grows due to some degree of public goods properties of R&D. On the other hand, it may be that future innovation challenges may require much larger R&D investments than those faced by the aquaculture industry at earlier stages. Sustaining future growth is clearly important regarding how much R&D is needed and who should finance it.

There is often substantial controversy surrounding aquaculture and its innovations. Among the most promising areas of innovation, but also most controversial, is genetically modified fish (Smith *et al*. 2010a). Aquaculture needs such radical innovations to sustain its growth, but to be able to implement these innovations commercially it often needs the acceptance of important stakeholders and government regulators. The joint ability to produce radical innovations and receive sufficient acceptance in society to implement is going to be a central determinant of the aquaculture sector's future growth rate.

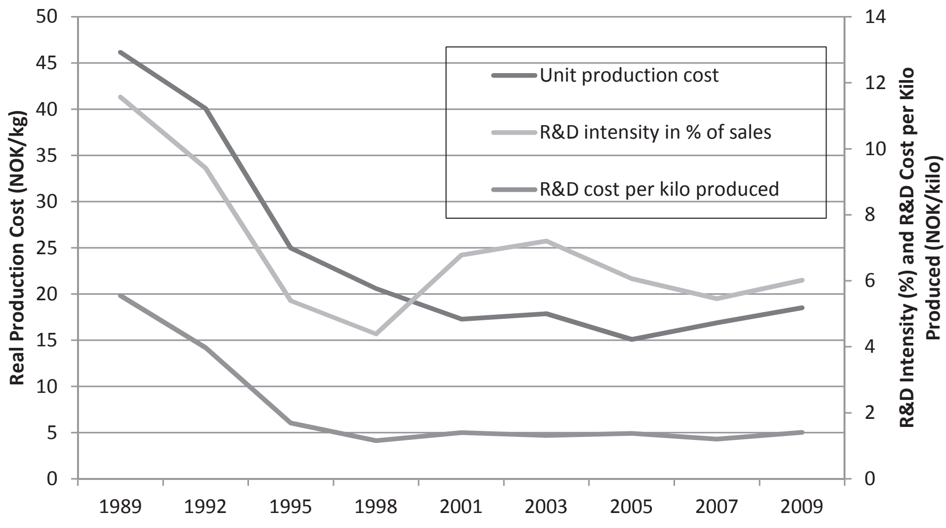

Figure 1. Real Production Costs and R&D Intensity in Percent of Sales and per Kilo Produced in Norwegian Salmon Squaculture

Overview of the Articles

The articles in this special issue address different aspects of innovation and structural challenges facing the seafood sector. They examine issues through the value chains from fishing vessels and aquaculture farms to the dinner table.

Downstream, the challenge for the seafood industry is to produce innovations in distribution and consumer products that increase the demand for its products. In the last two decades, the salmon value chain has been one of the most successful in downstream innovation. Asche, Dahl, Gordon, Trollvik, and Aandahl analyse the demand growth of Atlantic salmon in the EU and French markets. The two main factors that have determined the development for successful aquaculture species are productivity growth and demand growth. While we have substantial knowledge of productivity growth, insights are more limited for demand growth. Their article investigates 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. 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.

Expansion of seafood market demand requires increased understanding of how different product forms are interrelated and compete. Xie and Myrland contribute to this in a study of French salmon demand. Product aggregation levels in the seafood demand literature are normally selected based on the research objectives rather than empirical tests. This study applies the Generalized Composite Commodity Theorem (GCCT) to test the aggregation of French household salmon demand. The results indicate that demand for salmon can be aggregated based on product forms (*i.e.*, fresh, frozen, and smoked salmon). These composites can be further aggregated into a single salmon category. Salmon demand can, therefore, be estimated using a system which includes only salmon equations. The composite demand elasticities estimated by the AIDS model suggest that fresh and smoked salmon significantly substitute each other in the French salmon market. This means that the estimation of an import demand system that does not include smoked salmon cannot explain real consumer demand well. The results also suggest that wild salmon is playing in a different market niche than that of farmed salmon.

Since aquaculture uses common resources for its farm production, it is highly dependent on the perceptions of other stakeholders, including consumers. Hansen and Onozaka analyse impacts of disease in aquaculture through an experimental study that measures spillover effects from negative publicity. Aquaculture, as with all animal production, is exposed to diseases which can cause negative publicity and market impacts. A recent example is the Chilean salmon farming industry, which is currently facing unprecedented economic losses due to an outbreak of infectious salmon anemia. Hansen and Onozaka conducted two consumer experiments to investigate spillover effects of negative publicity on consumer valuation of seafood products from unaffected countries and species, as well as a potential mitigating strategy that an affected industry might use. They find significant negative spillover effects on the same species produced in unaffected countries and on other fish species farmed within the affected country. They also find that building a brand association with an upscale retailer does not improve consumer valuation (*i.e.*, no positive spillover effects) of products from directly and indirectly affected countries of the affected species.

There are probably substantial innovation opportunities in the fisheries sector in many countries. This is partly due to government regulations that have provided constraints and incentives which lead to inefficient solutions in several dimensions, such as vessel and gear technologies and harvesting strategies. Guttormsen and Roll investigate technical efficiency in Norwegian groundfish fisheries. Most fish stocks are targeted by different fleets using different types of vessels and gear. Heterogeneous fleets can contribute to variations in vessel performance, as the potential of each vessel type and gear differs when it comes to harvesting fish. Different management regimes among vessel groups can amplify these variations. To explore this issue, the article investigates differences in efficiency between and within vessel groups in the Norwegian groundfish fleet. Whereas efficiency differences within a group of relatively homogeneous vessels reflect managerial abilities, efficiency differences between different groups of vessels reflect the use of different technologies and/or management regimes. Guttormsen and Roll's results indicate the presence of significant inefficiencies. Given the substantial variation in technical efficiency both between and within vessel groups, both managerial skills and an inefficient management regime in the study fishery are documented.

The aquaculture industry needs to expand the production of high-valued species that is subject to high pressure from the catch sector. Bluefin tuna is such a case, where capture-based aquaculture represents a necessary stage on the way to a more sustainable closed-cycle production. Shamshak presents an economic evaluation of capture-based bluefin tuna aquaculture on the US East Coast. The article examines the potential of this hybrid form of aquaculture production to increase the net economic value generated in the US East Coast bluefin tuna fishery. A bioeconomic model of an offshore capture-based bluefin tuna aquaculture facility is used to evaluate the economic feasibility of this form of production under a variety of economic, biological, and regulatory assumptions. The second part of this article assesses the extent to which the opportunity to engage in capture-based bluefin tuna aquaculture production could improve the net economic value generated in the US East Coast bluefin tuna fishery. The results suggest that if the fishery had the opportunity to engage in capture-based bluefin tuna aquaculture production, there would be an increase in the net revenue generated in the fishery.

Salmon farming has been a driver of innovation in intensive aquaculture since the 1980s. But in the last 10–15 years there have been indications that its innovation rate has not been sufficient to increase productivity at the same rate as in the earlier stages. Vassdal and Sørensen Holst examine technical progress and regress in Norwegian salmon farming using a Malmquist Productivity Index (MPI) approach. In their study they measure change in total factor productivity for production of Atlantic salmon in Norway from 2001 to 2008. Their results demonstrate that total factor productivity change measured by MPI increased from 2001 to 2005, but thereafter regressed. This is due to a regress in the technical change component of the MPI. Vassdal and Sørensen Holst interpret this result as an indication that the industry has reached a level of technological sophistication from where it is difficult to make substantial progress. For an individual producer it may still be possible to improve efficiency by catching up relative to the best practice frontier. When this possibility is exhausted, the total factor productivity change for the industry may come to a halt.

One of the main challenges facing several seafood sectors is the substantial volatility in prices that entail cost for agents in several stages of the value chain. This is certainly the case for farmed salmon, which is still unable to compete with other meat-producing sectors in terms of providing raw materials at reasonably stable, predictable prices. The article of Asheim, Dahl, Kumbhakar, Oglend, and Tveteras analyses the impact of prices and biology on the short-term supply of farmed salmon. The short-term relationships between the supply of farmed salmon and its market and biological determinants are not fully understood. An econometric model of salmon supply is estimated exploiting monthly data on Norwegian salmon aquaculture. The estimates indicate that supply has shifted over time due to innovations in several areas. However, the price of farmed salmon has a limited effect on supplied quantity, giving a highly inelastic short-run supply elasticity and thus is a source of price volatility. The biomass and seasonal factors are the main determinants of shifts in salmon supply in the short term.

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