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Path dependency, institutionalization and co-evolution: The missing diffusion of the blue revolution in Norwegian aquaculture

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ABSTRACT

Scholars taking the evolutionary perspective argue that technologies, competence and institutions of successful paths may spill over to related industry initiatives and subsequent industry paths. The notion of co-evolution has been introduced as an analytical category for such interconnectivity. In this article, we investigate the development of salmon farming in Norway as a successful industry path and its linkages with cod farming, a subsequent emerging industry path. In the public debate, there has been an expectation that knowledge and solutions from salmon farming will diffuse to aquaculture for other species. However, this diffusion appears to be missing. Cod farming is an area that should capitalize on the success of salmon aquaculture, and we investigate why cod farmers appear to be unable to utilize the experience and knowledge of salmon farmers and copy their solutions. We found that the development of a specialized institutional arrangement for salmon farming makes these models incompatible with the needs of farming of other species, resulting in limited co-evolution between subsequent aquaculture industry paths. Thus, a situation characterized by strong co-evolution *within* an industry path, facilitating the development of an institutional arrangement tailor-made for the firms of the industry, reduce the possibilities for co-evolution *between* related industry paths.

1. Introduction and research question

Salmon aquaculture is an important part of the Norwegian seafood complex. This complex consists of fish farmers and fishing vessels, processing firms, technology suppliers, sales firms, research institutions, investors, supporting institutions and a regulatory framework. Firms and organizations are often operating within several segments of this seafood complex. The narrative of the Norwegian blue revolution created an expectation that accumulated aquaculture knowledge and solutions from salmon farming would diffuse to other parts of the seafood complex, and contribute to the development of a range of profitable aquaculture species (Report to the Storting, 2004–05). However, this diffusion appears to be missing, or is, at best, relatively restricted. Despite optimistic plans and strategies, the production of other aquaculture species has been modest (Directorate of Fisheries, 2013a, Directorate of Fisheries, 2014). In this study, we demonstrate how salmon farming successfully has utilized available resources, while related aquaculture initiatives, exemplified by cod farming, have failed.

Inspired by the evolutionary perspective and path-dependence theory, we investigate the development of salmon farming in Norway as an industry path, emphasizing the development of its institutional arrangements (Boschma and Martin, 2010). Historical junctures have permitted particular trajectories, which again have provided an institutional framework for the salmon farmers. First, we identify crucial junctures, and demonstrate how a strong industry path has been developed through self-reinforcing processes and institutionalization (Martin and Sunley, 2006; Frenken and Boschma, 2007). Second, we elaborate on the linkages between salmon aquaculture and cod farming, a related aquaculture initiative. Scholars taking the evolutionary perspective argue that technologies, competence and solutions from successful paths may spill over to related industry initiatives and subsequent industry paths (Martin, 2010).

We introduce the notion of co-evolution as an analytical category for understanding connectivity between related subsystems. The literature differentiate between co-evolution within an industry path (e.g. between the firms' subsystem and the institutional

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subsystem) and co-evolution between industry paths (Schamp, 2010). Despite the popularity of the concept, there is a lack of literature on the main mechanism by which such co-evolution occurs or not, and how co-evolution is linked to institutional conditions (Murmann, 2013). Our point of departure is the observation that cod farming does not seem to learn from the experience and knowledge of salmon farmers, and we want to identify mechanisms that seems to prevent co-evolution between a hegemonic path and a related subsequent industry path. In relation to this, we also want to investigate how co-evolution within an industry path, i.e. between the firms and the institutional framework in salmon farming, influence on the occurrence of co-evolution between subsequent industry paths. The evolutionary perspective is lacking a "*… detailed account of how these co-evolution processes take place*" (Murmann, 2013: 1). We need to know what is co-evolving with what and why a situation of potential co-evolution between industry paths is not being materialized (Schamp, 2010). Thus, our article contributes to a more nuanced understanding of the different dimensions of co-evolution and its significance for industry development. In light of this, the article will focus on the connectivity between salmon and cod farming, and investigate three areas of potential connectivity; production technology, sales regulation and R&D organization.

Cod is an important wild-fish species in Norway, and there is an established infrastructure for catching, processing and marketing the fish. There are also available solutions to resolve the technical and biological challenges of cod farming. Cod farming and salmon farming are both part of the Norwegian seafood complex and have several similarities when it comes to technology, knowledge and research needed in the production and marketing of the product. Many of the actors have operated within both segments (Aarset, 1999). Thus, they are related industries, and cod farmers have the opportunity to capitalize on the proven successes of salmon aquaculture. Nevertheless, we have witnessed a lack of co-evolution between salmon and cod aquaculture, and the latter has not prospered as an industry path. One obvious explanation for this lack of co-evolution is the difference in market conditions, in various ways formed by the relation between the farmed cod and salmon and their wild caught counterparts. An important 'take-off' factor for farmed salmon in Norway during the 1970s was the price premium gained because wild salmon was a high-priced product. As an emerging path with an immature technological set-up, the salmon farming pioneers experienced high production costs. During the 1980s, the real prices for farmed salmon decreased due to rising production volume, but farmers learned from trial and errors and were able to reduce their production cost correspondingly and still make a profit (Jakobsen, 1999). For the first cod farmers the situation was opposite. While the price premium of the wild salmon market fueled the initial technology development of salmon farming, the price of farmed cod was destined to follow the more modest price level of wild cod and related white-fish products. Cod farmers tried in vain to achieve a price premium for the farmed cod product, but they have failed to make profit due to relatively high capture volumes and low market prices in the wild fish sector.

In this article, we want to move beyond the differences of the market as the sole explanatory factor, and discuss the specific solutions and institutions that characterize the two industry paths. We believe that a focus on institutional factors will provide us with additional insight into the missing diffusion of the blue revolution in Norway. We understand institutions as the shared routines, practices and values developed within a system and formal institutions influencing the practice of economic actors (i.e. policy regulations) (Martin, 2010). In the article, we elaborate on the following research question: how does institutional factors influence on cod farmers' abilities to extract useful solutions from the experience and knowledge of the salmon farmers? Moreover, we also have to keep in mind that the biological differences between salmon and cod will influence learning between the industry paths. These differences are especially important when it comes to the attempts to copy production technology. The hatched salmon fry, for example, is relatively big and robust and can feed on industrially processed fodder directly. The newly hatched cod fry are very small, and a higher level of skill and technological competence is necessary to process adequate fodder and feed the fry.

We start by presenting contextual information about salmon and cod as species and as targets for aquaculture (Section 2), followed by our theoretical framework (Section 3), and a run-through of material and methods (Section 4). In the empirical part of the paper, we outline the development of salmon aquaculture as an industry path (Section 5), before we discuss interconnectivity between cod and salmon farming (Section 6). The final section links our empirical observations to the theoretical discussion (Section 7).

2. Salmon and cod as farmed and wild species

Salmon and cod are the main species in the Norwegian seafood sector – salmon as a farmed species, but also as a target species in a very limited professional and a recreational fishery – cod as a main target species in the marine fisheries, but also as a species of a limited farm endeavor (see Figs. 1 and 2). Institutions regulate human behavior, such as the behavior of farmers and firms involved in aquaculture. To identify the evolutionary traits of the institutions that regulate behavior in salmon farming and how they fit – or do not fit – with the requirements of the cod farmers, some biological and historical information will be accounted for here.

The Atlantic salmon, the most common species in salmon farming globally, is an anadromous fish that spawns in fresh water. The egg and the larva are relatively large (small fry 2–3 cm). In the wild, the juveniles stay in the stream for two to six years, until their physiology transforms, and as a smolt (between 10 and 20 cm long), it is ready for departure to the sea. The salmon stays at sea until it reaches sexual maturity and then returns to the river. The salmon is carnivorous and thus adapted to an entirely animal-based diet.

Atlantic salmon farming consists of three stages; the breeding/hatching stage, the production of smolt, and the grow-out stage (Skagemo et al., 2014). Downstream the value chain follows slaughter, processing and packing, transportation, export and trade. The main grow-out technology is open net pens, a relatively simple set-up where the surrounding water flows in and out of the pens. The structure of the firms and the scope of the subsidiaries have developed continuously for four decades, and vertical and horizontal integration is common. In Norway, the number of farm licenses has been around one thousand since the 1990s (Directorate of Fisheries 2013a), but ownership concentration is rising, and the number of firms is reduced from 259 in 2001 to 130 in 2011. In 2011, the 11 largest firms controlled 54% of the total stock of Norwegian salmon (Statistics Norway, 2012). Due to persistent growth, the yearly production of farmed salmon in Norway reached 1.2 million tons in 2013, with a first-hand value of 4.7 billion EUR (Statistics Norway, 2014).

Historically, wild capture of salmon is conducted either by various trapping technologies in the fjords and river mouths, or as a recreational fishery in the rivers. The fishery has had regional value in combination with other sources of income, but in economic terms, the fishery is negligible compared to the salmon farming industry (Fig. 1). The following two aspects have particular importance for our study. First, in the industry's infancy, up to the early 1980s, the high-end luxury market purchased farmed salmon