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Multinational companies embedded in national innovation systems in developing countries: the case of Norwegian fish farming multinationals in Chile

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Abstract

This paper looks at how Norwegian multinational fish farming companies are embedded in the innovation system in Chile. The empirical part is mainly based on interviews with industry representatives in both countries as well as literature and document analyses. There are around 50 Norwegian companies in Chile, most of them involved in salmon farming and supporting activities. Few of them have, however, decided to invest heavily in R&D and innovation locally, and they generally seem to follow a "national treasure" internationalisation strategy where most R&D is kept in the home base. The data indicate that uncertainties about costs, perceived high risks, cultural differences and weak university-industry relations in Chile are some of the factors behind these decisions. A general policy implication is therefore to strengthen university-industry relations in various ways, and the companies welcome such recent initiatives.

1 Introduction

A central driving force in increased internationalisation of economic activity and technology transfer to developing countries is the strategies and activities of multinational companies (MNCs). Investigations show that these processes rarely imply convergence between countries and regions (see Cantwell & Molero 2003). Instead, internationalisation leads to decentralisation which tends to reinforce local strengths, weaknesses, specialisations and industrial patterns of technological change. This is a challenge for sustainable growth and development. Many multinational companies are already strongly embedded in one or a few national systems of innovation (Patel & Pavitt 1998), and foreign expansion will not necessarily mean that they will contribute significantly to systems of learning, innovation and competence building in the host countries (e.g. Gulbrandsen & Godoe 2008). MNCs can play a decisive role in technology transfer to indigenous firms, but this requires integration into the innovation system that may take a very long time to achieve (Cantwell & Molero 2003).

This paper looks at the integration or embeddedness of MNCs in a developing country, using Norway, Chile and the fish farming industry as a case. Norway is among the largest producers of aquaculture salmonids in the world. As the industry has matured, the degree of internationalisation has increased, and fish farming is now one of Norway's most internationalised industries. Norwegian firms own large shares of the aquaculture industry in Chile, a developing country that engaged in commercial fish farming some 30 years ago, profiting highly from Norwegian developed technology and expertise.

We ask whether Chilean fish farming has been able to build its own innovation capacity during these years, or if it is still dependent upon technology transfer from MNCs. This question is of great importance to the Chilean industry today, not least in light of a recent crisis with an extensive spreading of the disease Infectious salmon anemia (ISA) which has led many companies in Chile to close down their fish farms (see Seafood Business, January 2008). More generally, Chile depends upon new technology and new means of production to compensate for weak infrastructure in non-utilised fish farming area. The farm density is very high in the leading aquaculture region – probably one reason behind the spread of ISA – and new localisations are not possible there.

An important issue in this paper is to understand the implications for emerging economies, such as Chile, of the potential transition to global innovation networks. What are the implications of MNC's location of knowledge intensive activities for regional development? What is the capacity of a country like Chile to build national innovation systems that allow them to participate in global innovation networks as opposed to global production networks? Our case should be interesting due to e.g. the three decades of experience-based learning and the relevance of aquaculture to many developing countries.

2 Theory and previous research

In this section, we set up a framework of analysis based on literature about multinational companies, R&D/innovation and internationalisation, and the concept of national systems of innovation with emphasis on developing countries.

2.1 Multinational corporations

According to Dunning (1993: 4) a multinational firm is, *'engaged in foreign direct investment (FDI) and owns or controls value-adding activities in more than one country*.' Bartlett and Ghoshal (1989) add that the MNC needs to be engaged in the active management of these offshore activities. Geographical dispersion of activities entails companies to manage complex organisational structures and management systems that require control over its product and its functional and geographical diversity, which includes linguistic and cultural aspects.

Traditional approaches to the firm's multinational growth (Vernon 1966) argue that firms going abroad must possess ownership advantages allowing them to overcome their 'liability of foreignness'. It was emphasised that coordinating international innovative activities was too costly, due to the difficulties of collecting and controlling relevant information across national borders. The R&D activities were largely limited to the adoption and diffusion of centrally created technology. From this point of view, learning and transfer of knowledge entails a one-way movement from parent companies to subsidiaries. These traditional contributions are influenced by classical economic theory of profit maximizing and rational agents, rather than evolutionary streams embracing complexity. Nonetheless, this literature has created framework in which newer streams of development towards a 'modern' MNC where evolutionary theory has been given more attention.

Multinational corporations from developed countries have long used vertical fragmentation of their manufacturing production in different locations to improve the efficiency of their operations, and as such, been part of global production networks. MNC's decentralisation of production processes has multiplied developing countries' links with global production networks in a wide range of sectors. The trend has been the outsourcing of so called non-core activities, concentrating resources on the perceived core business in home country (such as R&D departments and innovation activities). Production capacity and market access has for long been the main motivation and driving force for firms' internationalisation strategies (UNCTAD 2005).

2.2 Internationalisation of R&D and innovation

Internationalisation of R&D and innovation activities has been going on for at least several decades – and it increasingly takes place in most industries and most parts of the world (Niosi 1999; Narula & Zanfei 2002, 2005). The trend the last years is that firms are internationalising more of their knowledge intensive activities, even though it has not grown proportionally to firms' overall internationalisation of production activities (Criscuolo et al., 2004). The picture contains many nuances. For example, advanced research remains concentrated in a few global regions, while development activities often follow production facilities, marketing units and users into new-to-the-firm countries and regions (e.g. von Zedtwitz & Gassmann 2002).

Some have hoped that internationalisation can contribute to building sustainable systems of innovation in developing countries, but there is much evidence that firms still tend to concentrate their long-term R&D activities "at home" (Pearce & Singh 1992; Patel & Vega 1999; Narula 2002; Edler 2003). The reasons are various types of "lock-in" and inertia like close ties between companies and public research and education institutions – implying that internationalisation on a significant scale most frequently happens accidentally through mergers and acquisition or as a result of a "mismatch" between the needs of the companies and the orientation of universities and research institutes.

Characteristics of the firms like size, strategy and industry also influence patterns of internationalisation. Von Zedtwitz & Gassman (2002) distinguish between four types of firms' strategies. The most common type is the "market-driven R&D" where research is concentrated at home while development activities follow the markets in which the firm has a

presence. Another common type is "national treasure R&D" where R&D activities are predominantly found in the home country of the firm, often due to the firm having a very strong position in an international market. The implication is that even though foreign locations may provide the firms with some benefits or solve certain problems, there are strong forces of concentration at work (cf. Pearce 1989).

The literature emphasises a two-way linkage between innovation and internationalisation (Castellani and Zanfei, 2006): Internationalisation of innovative products or processes may enhance firms' possibility to make profit in new markets. Complexity and competition in foreign markets and the possibilities that companies acquire more knowledge in local or affiliate markets (Zanfei, 2000, Narula and Zanfei 2004, UNCTAD 2005, Maskell et al. 2006), may improve or expand innovation activities. MNC's subsidiaries' external connections with institutions and actors are important in order to access local context specific knowledge. This knowledge can be complementary to MNCs internal knowledge generating processes and can be seen as a strategy to upgrade core competencies and to improve competitive advantages. Such local knowledge generating networks can help subsidiaries to develop their own specific knowledge, if the networked partners take active part in interactive learning processes.

2.3 Developing countries and the local context

Local contexts and context-specific knowledge has become more decisive in the internationalisation processes of MNCs. According to Castellani and Zanfei (2006) the changing nature of scientific and technological progress enhances the role local contexts as a source of economic value for innovating firms in some cases. In other words, context-specific knowledge often makes the difference and determines the competitive advantage of firms. Context-specific knowledge is seen as highly complementary to the development of general and codified knowledge. Advancements in information processing and communication technologies create incentives for firms to codify knowledge and lower the costs of exchanging information between different and distant nodes of the MNC's internal network.

Zanfei (2000) asserts that manufacturing and sales subsidiaries outside of the home country function as a fundamental instrument for assimilation of local culture, objectives, norms and conventions. In turn, assimilating local habits and values improves MNCs' abilities to understand and anticipate the behaviour of host countries' firms and institutions, explore user needs and technical competencies, absorb locally generated innovative ideas; and, last but not

least, select partners and increase the effectiveness of external networks with indigenous counterparts (ibid: 517).

Katz (2007) raises an interesting issue about industries dependent upon natural resources in developing countries and their local context: how much ´location-specific´ R&D efforts are needed as a result of the idiosyncrasy of local production circumstances? Although considerable parts of the required scientific knowledge and technical know-how could be obtained from international sources, he claims that is important to understand that natural resources are often "country-specific", requiring processes of domestic knowledge generation and adaptation. Local production environments tend to differ whether they are ecological, biological or physical conditions. In the framework of developing a sustainable and rational exploitation of domestic natural resources, Katz claims that it is not sufficient to adhere to the notion that readily available production and environmental control technologies will automatically solve subsidiaries' challenges. Thus, domestic R&D seems to be required to secure sustainable development. This process has to be coordinated with the external environments consisting e.g. of public R&D institutions and administrative and political institutions. However, the study emphasises that Latin-American firms have until now not shown many signs of an increasing interest in developing in-house R&D activities or strengthening their links with local universities, public labs or engineering firms (ibid :18).

2.4 Using the concept of NSI in a developing country

The processes of competence building and innovation are the focal points in innovation system analyses, focusing on how enduring relationships and patterns of dependence and interaction are established, evolve and dissolve as times goes by (Lundvall, 2006, p. 8). The national system of innovation approach pointed to the importance of the active role of governments in promoting a technological infrastructure, and the need to consider how technological systems come forward and how they match or mismatch with the existing national patterns of institutions (Freeman 1982, p.18). Lundvall (1992, p. 1) emphasises the interaction of various elements "in the production, diffusion and use of use of new, and economically useful knowledge".

The concept of the national system of innovation (NSI; Freeman, 1987; Freeman and Lundvall 1988; Lundvall 1988, 1992) was based on empirical work in advanced industrialised countries, however, its applicability is not confined to these countries and can be useful for

studying the specificies of innovation processes and policies in the South (Arocena and Sutz, 2000, Mytelka, 2004) as innovation can also be seen at the core of upgrading and growth also in developing countries (Giuliani and Bell, 2005, Lundvall et al., 2006). Strengthening the NSI is equivalent to improving the feasibility of innovation, however, the NSI needs to be complemented and adapted to a southern perspective. According to Arocena and Sutz (2000), the concept originated in central countries as an ex-post concept while in the periphery the concept is basically an ex-ante concept.

Arocena and Sutz (2000) state that industrial innovation in developing countries is not a product of formally articulated R&D activities (it is highly informal), and that dominant cultural patterns of these countries undervalue scientific knowledge and technological innovation. Gu (1999) suggests that NSIs in developing countries have not developed the technological and institutional properties necessary for modern growth. Further, capital accumulation, rather than intangible assets such as knowledge and learning is and has been the main contribution to technical progress in developing countries (*ibid.*). Intarakumnerd (2002 p. 1445) argues that the specific nature of the NSI and related problems in many developing countries (such as countries in Africa or Latin America), are different both from developed countries and 'learning intensive' developing countries.

Even though technological innovation is present in Latin America, there are few patterns of socio-economic behavior regarding innovation that can be viewed as working in a system-like manner (Arocena and Sutz, 2000). Further, endogenous generation of scientific and technological knowledge was not an important factor for economic growth in Latin America, but rather a strategy of technical change consisting of imports of capital goods (*ibid.*). In some sense the interaction between state and industrial entrepreneurs were 'systemic', however it was not focused on innovation.

Latin American NSIs are part of the international economy that specialises in the 'natural resource' based production, with mostly imported 'technological added value' (*op.cit.*, p. 67), suggesting that Latin American NSI are weak indeed. The explanations to this can not only be ascribed to failures between the components of the system but also to "…the social and economic value historically assigned to endogenously generated knowledge and innovation are explanations at least as powerful" (Arocena and Sutz, 2000 p. 71). Further the lack of

social consensus on national efforts directed towards knowledge and innovation is also an important reason of the lack of well-functioning NSIs in Latin America.

3 Methodology

The paper will present empirical findings from a qualitative study of Norwegian multinationals with subsidiaries in the Chilean aquaculture industry (Astroza 2008). Formal interviews have been carried out in the head offices in Norway and subsidiaries in Chile. Information was also gathered through formal and informal meetings at seminars and conferences during a month in January 2008 in Chile. In the following we include a short presentation of the companies that were part of the empirical investigation.

One Fish Farming Company: Interviews were carried out with people working in both the central offices in Norway and the subsidiary in Chile. The company has operations in the all the major international markets where salmon is produced. Additionally the company is engaged in value added process activities across the world.

Three Fish Feed Companies: two of them were of Norwegian origin and one entirely Chilean owned.

- *Fish Feed Company 1*. Interviews were carried out in Norway at the central offices and in the subsidiary Chile. The company is one of the leading producers and has operating companies on five continents to supply feed for many species of farmed fish. The company has an R&D department in Norway.
- *Fish Feed Company 2*. One interview was carried out in the subsidiary in Chile. The company is one of the leading suppliers of feed to the aquaculture industry. They have a central R&D department in Norway and a smaller R&D unit in Chile.
- *Fish Feed Company 3.* One interview in this entirely Chilean-owned feed company. The company has extensive operations in the Chilean market. It used to have an R&D unit, but it is now seeking collaboration through specific projects instead of its own separate R&D department.

One Supplier of Technological Equipment: Interviews with employees in both headquarters in Norway and in the subsidiary in Chile. The company is one of the principal producers of technological equipment to the aquaculture industry. It is present in more than 10 countries across the world and is engaged in all kinds of activities in the value-added chain.

One Research Company in Chile: One interview in their offices in Chile. The company is newly established as a joint collaboration between Norwegian research institutions, who are supplying research, knowledge-based solutions and consultancy services to the Chilean salmon farming industry.

4 Background: Aquaculture in Norway and Chile

Aquaculture is the farming of aquatic organisms including fish and implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. The management of an aquaculture system is a balance of many elements, including the calculation and implementing of feeding, stocking, testing the water quality, and eventually harvesting of grown fish. The farming of fish is often viewed as a low tech industry, and in many countries the activity is carried out with very few resources. On the other hand, the large global commercial players have developed well functioning sectoral innovation systems (Aslesen, 2009) where all parts of the value chain are highly knowledge intensive:

> *"Since agriculture began, farmers have been overcoming the obstacles that nature has raised against them. However, the time when farmers removed all obstacles on their own is long gone. This is also true for aquaculture, not only for the modern aquaculture entrepreneur but also for the small-scale, commercial fish farmer in developing economies. In modern aquaculture, development is now a joint effort among farmers, investment concerns, equipment manufacturers, service suppliers, scientists and government". (FAO 2009, p. 158).*

4.1 The aquaculture industry

In the 1970s, aquaculture accounted for about 6 percent of fish available for human consumption; in 2006, the figure was 47 percent (FAO, 2009). Aquaculture is a global industry, carried out in both developing and developed countries. However, different countries dominate in the production of major species groups; e.g. China produces 77 percent of all carp and 82 percent of the global supply of oysters (ostreids), while the Asia and Pacific region as a whole accounts for 98 percent of carp and 95 percent of oyster production. Norway and Chile are the world's leading producers of cultured salmons (salmonids), accounting for 33 and 31 percent of world production (FAO 2009). As a productive sector, aquaculture has now claimed a significant role in many developing countries, such as Chile, Ecuador, the Philippines and Thailand (Barton and Fløysand, 2008)

The rate of growth in aquaculture production is slowing due to various constraints and obstacles. Policy actors and the industry have aimed to identify the most important constraints in the near future (FAO 2009). The need for knowledge in the industry has exploded; as the industry has become global, so have e.g. the various threats stemming from transboundary aquatic animal diseases. Serious disease outbreaks have occurred over the past few decades, causing significant damage to the industry and losing billions of dollars of revenue (FAO, 2008). Other issues regarding environmental and sustainable development need to be addressed, and the fact that the capture fisheries input into salmon aquaculture have conversion ratios in the order of 2.6-3.3kg of captured fish to 1kg of salmon (Deutsch et al., 2007), poses questions about the real contribution of the sector to feeding the world.

The pressures for scientific and technological development in the industry is still high, due to the complexity of the process and of the attention the sectors has been given from authorities, environmental groups and consumers the last years. In order to be a competitive global player in this industry, you need to be part of a dynamic national innovation system.

4.2 Aquaculture in Norway

Commercial farming of salmon and trout in Norway has been carried for about 40 years, however, the first known Norwegian initiatives within aquaculture came about in 1855 (Dietrichs, 1995). The following century was a period of occasional trials and errors, and a successful approach to farming salmon in a natural habitat was not found until 1967 when Thor Mowinkel managed to start raising salmon into an enclosed bay (*op.cit.* p.11).

Today Norway is the largest producer of Atlantic salmon in the world. In 2008, Norwegian seafood exports amounted to NOK 39.1 billion, setting a new seafood export record for the fourth year running. Norwegian exports of *farmed* seafood increased by NOK 1.2 billion to NOK 20.2 billion, representing export records for both salmon and trout. Aquaculture is Norway's most international industry and fish from the salmon family are exported from Norway to 98 countries.[1]

The explanations for this success are many, like a combination of private entrepreneurship and government incentives, the sector's ability to develop networks with science and suppliers and the rapid learning and innovation taking place. Norway was quick to build educational

[1] For more general information, see http://www.seafood.no.

establishments supporting the aquaculture industry compared to other salmon producing countries. A strong market demand for salmon and the well-established existing distribution and sales systems from the fisheries sector also explains the rapid growth.

In aquaculture breed-, feed- vaccination- and technology suppliers are important sources of new knowledge. The supply industry directed towards aquaculture in Norway are world leading in many of the inputs that feeds into the sector. Around 20 public, semi-public, and private research institutes in Norway perform R&D in aquaculture. Technological and commercial success has been considerable; for example, Norwegian institutions and companies have developed and established the most advanced breeding systems for fish and shellfish worldwide, and Norwegian breeding companies are established in the most important salmon farming countries (Olafsen et al. 2006). When it comes to feed, Norway has been a centre for research on feed for salmon aquaculture since the 1980s and has a high international standing. Further, the Norwegian aquaculture technology suppliers are becoming global actors with most of their technology development activities still in Norway.

Government regulation has played an important and growing role in the development of Norwegian aquaculture (Jakobsen et al. 2003). The industry has also experienced radical institutional changes during the past four decades (Aarset and Jakobsen, 2009):

- In the 1970s and part of the 1980s, institutions were aimed at supporting the industry as a competitive rural enterprise (the corporate strong state era).
- In the end of the 1980s, a significant overproduction problem occurred, leading to the collapse and elimination of two major institutions in 1991: the mandatory organised first-hand sale and the ownership regulation (the era of change/liberalisation)
- From 2001 and onwards there has been an era of re-institutionalisation characterised by a process of depoliticising the industrial regulations, however, the control aspects have been fortified through a stronger emphasis on the efficiency of the industry and the approval of international standards and obligations.

It may be added that a similar process with a strong political role for the authorities in shaping new institutions was seen at around the same time in the petroleum industry. A political innovation here was the technology and goodwill agreements which granted drilling rights to foreign companies in exchange for obligations to invest in R&D in Norway. This policy is in

retrospect regarded as extremely successful, and it has presently gained the attention of a number of Latin American countries dissatisfied with the role of MNCs within their borders.

According to Aarset and Jakobsen (2009) the new control and monitoring regime in Norwegian aquaculture means that power structures have changed and expert institutions have achieved a more prominent position. Further, Norway's international position along with its competitive situation has made the national political-administrative institutions adopt a more international perspective in their evaluation of regulatory principles. Policy-makers and the industry itself persist that the challenges are still to facilitate continuous learning and innovation.

4.3 Aquaculture in Chile

Chile is a leading player in global salmon production and exports. The success has been made possible through good climate conditions and an abundance of freshwater resources. The aquaculture industry employed 24.700 persons in 2005, 85 per cent of the production is found in the Los Lagos region (Puerto Montt and Chiloe Island, *Region X*). Today the aquaculture export has captured large shares of the total export from Chile, however, heavily challenged by biological problems.

According to Barton (2006), salmon aquaculture was one of several non-traditional export sectors promoted from the late 1970s in order to diversify the Chilean economy away from its traditional dependence and export of natural resources like copper, fruits, wood and wine. The initiative to salmon farming was combined with international development assistance by the Japanese development agency (JICA) together with Fundación Chile. These two projects together with the conditions offered by the Chilean fjord landscape gave rise to the industry in the early years. The first commercial actors were in the market around 1980, 10 years later than in Norway (Liabø et al 2007). This period was characterised by strategic partnership between public and private actors that facilitated the adaptation of superior foreign technologies (Kjesbu et al. 2005). Actors in Chile took advantage of technology that had already been developed in Norway.

International and multinational investments, competence and technology have been highly influential in the Chilean sector. According to UNCTAD (2006, p. 17) there has been a technology upgrading in Chile and the process has gone from technology transfer, imitation

and adaptation to the development of endogenous innovation capabilities. By the 1990s Chilean investment increased and the majority of actors were medium and smaller-size domestic firms (Barton and Fløysand, 2008). However, the ensuing period was characterised by mergers and acquisitions as international prices of salmon led to the exit of smaller firms. This process has led to a global integration of the Chilean salmon farming and to a consolidation of the industry into a few large players.

According to Kjesbu et al. (2005) the Chilean actors that entered into fish farming had experience from other industries based on natural sources, having a business orientation preoccupied with creating suitable structures for profitability. The way of thinking in Chile has been industrial and market oriented from the start; the salmon farmers have themselves been engaged in marketing and sales, giving them an advantage with respect to understanding trends and demands from customers (Liabø et al., 2007 p. 50).

Much of the growth phase of the aquaculture sector took place in a weak regulatory regime and within a spatial context of low levels of economic and human development (Barton and Fløysand 2008). R&D was principally organised around productive aspects of the sector such as disease control, feed development and management, genetic adaptation, and diverse associated technologies. According to OECD (2007), R&D in the Chilean industry is carried out by individual firms with intention to generate competitive advantages. Recent news has revealed that the public sector is planning to increase the amount of public funded R&D[2].

Chile today depends on new technology and to changes in operating conditions to compensate for weak infrastructure around localities that have not been used. In Region X, the density and location possibilities are strained to the limit. The absolute cost difference between Norway and Chile diminished in the period 2005-2006, and the productivity in Chile worsened in the same period having an effect on all segments of the cost structure (Liabø et al., 2007).

Counter-seasonal advantages offered by Chilean harvesting times compared to Norway, natural conditions (localities and water temperature), market access, lower costs and policy conditions were motives that made Norwegian fish farming companies look to Chile. The company Chisal was the pioneer among Norwegian investors, established in Chile in 1984.

[2] 'Chile innovation investment 'may hit US$200 million' Published 05/02/2008 http://www.scidev.net/en/news/chile-innovation-investment-may-hit-us-200-million.html

There are currently 50 Norwegian companies in Chile, of which the greatest part is related to the salmon industry. These actors are mostly subsidiaries of Norwegian MNCs and account for one-fourth of Chilean aquaculture (Liabø et al 2007). Firms from Norway are engaged in fish farming, feed production, equipment supply and specialist knowledge/technology.

5 Empirical findings

This section will be based on the empirical evidence from the study of Norwegian MNCs in Chilean aquaculture, to what extent they have internationalised their innovative activities (Astroza 2008). We first discuss whether Chilean fish farming has moved from being low-cost and counter-seasonal production facilities to innovation-generating facilities, followed by a discussion of the contextual factors that influence the local capacity building.

5.1 From production to innovation?

The main objective of this paper is to answer whether the Chilean salmon farming industry has been able to build its own innovation capacity – and to explore the embeddedness of the Norwegian multinational companies in the innovation system in Chile.

One clear indication is how R&D units are organised within the MNCs. Besides *Feed Company 2* and the newly established *Research Company*, none of the contributors have an R&D unit in Chile. *Feed Company1*, *Farming Company* and *Equipment Company* regard a centralised R&D organisation in Norway as more effective than "splitting" resources across the MNC structure. The interviews indicate that one-way transfer of technology has been and still is perceived as a successful strategy among Norwegian MNCs in Chilean aquaculture. Two dimensions seem to be important in this context; *technological change* and *complexity in innovation and knowledge processes.*

It is indicated that the race for staying competitive is positively correlated with the intensified application of technological solutions. While the Norwegian industry has been considered as the frontrunners in applying new technological solutions, the Chilean industry has not experienced the same levels of technological adoption. This is partly explained by the higher use of manual labour in Chile compared to the Norwegian industry. As a consequence the necessity for applying technological solutions in Chile has not been as decisive as in Norway. The interviewees stressed that there is a growing perception of applying more technology in

Chilean aquaculture, especially since the future growth is expected to come in the extreme south, in regions with several infrastructural challenges.

At the same time, the adoption of foreign technology has enabled the Chilean industry's progress, reaching high levels of production and growth on a global scale. The downside of this reality is the vast usage of technological copy-products in Chile. This is mainly done in order to lower costs, which obviously has lead to lower quality in many products. The *Equipment Company* were aware of the problems related to copying, although they expressed that the magnitude is smaller for each year. However, related to the ISA outbreaks and other vast biological challenges the Chilean industry is currently facing, the use of pharmaceutical copy-products is a greater concern. It remains to see whether this is a declining tendency.

Executives in *Feed Company 1* and the *Farming Company* were very clear about the need, both for their companies and industry in general, for better documentation and focus on the practices that may function adequately in the Chilean context, as Katz (2007) emphasises. They still do not wish to create local R&D units, but rather take advantage of the quality knowledge that may reside in the Chilean system. This is obviously essential for building more innovative capacity in the Chilean industry. Although such behavioural patterns could be an indication of indirectly supporting an environment for innovative activities in Chile, it underscores the significance of questioning whether these preconditions are present. A community that is reluctant to utilise well-documented products stemming from research and other innovative activities do not contribute to a fruitful environment for innovative work, i.e. creating a framework for a better functioning national innovation system.

In other words, we find that the Norwegian companies so far do not play a very active role in the Chilean innovation system. Apart from the companies which offer R&D and technology as their main services and the new unit of *Feed Company 2*, they are reluctant to move R&D to Chile. Most of them seem to follow a "national treasure" strategy (cf. von Zeddtwitz & Gassman 2002) where the innovative activities are kept in Norway and transferred to other locations.

5.2 Contextual prerequisites for innovative capacity building

Given the Chilean industry's dependence of foreign created technology, it leads us to question how the innovation system can be strengthened through a closer participation and integration

by the MNCs. Three factors seem to be particularly important: the *local contexts for the establishment of local R&D units*, secondly the *infrastructure and surroundings* upholding innovative activities, and lastly *idiosyncratic or cultural features.*

Local contexts and R&D units

The perceptions of the need for specific local adaptation of technology differ between the Chilean and Norwegian interviewees. According to many of the interviewees in the Chilean offices, an increasing number of actors believe that technology and solutions made in Norway are getting more difficult to apply in Chile. Earlier it was discussed how technological development and change has enabled the salmon farming industry to mature and enabled knowledge bases to become more advanced and complex. As a consequence, there are specific qualities in the local environment that complicate matters more than before. But employees in the Norwegian offices did not share this view of the significance of local contexts in forming R&D and innovative work. A manager in *Feed Company 1* claimed that much of the unwillingness to apply Norwegian technology could be explained by the social phenomena "Not Invented Here" syndrome (a reluctance to accept outside perspectives), rather than great contextual differences between the countries.

The research manager of *Feed Company 2*, which had established a small, but formalised R&D unit in Chile, maintained that the principal objective was to "*perform research under Chilean conditions and reality, applying the challenges that are present there".* Furthermore, the manager expressed that important factors for the establishment are available, like competences and quality. Additionally he asserted that the costs of doing research are lower in Chile than in Norway. The Chilean unit is closely connected to and always in accordance with the central R&D department in Norway. However, the informant agreed that there are many deficiencies in the relations between academic institutions and the commercial companies in Chile. This was underscored clearly by all interviewees.

The newly established *Research Company* believes that all research performed in the Chilean context will be beneficial for their home [Norwegian] company as well, since it could possibly enable more local actors to understand the nature of research within aquaculture. This has to be viewed in relation to how the director of the Research Company expressed their aim of operating in Chile: '*The purpose is to build up a research company that could generate*

new knowledge for the development and strengthening of the industry in Chile, but at the same time strengthening the owner/home companies.'

The *Equipment Company* expressed through their CEO in Chile that they have had a previous experience with an R&D unit in Chile. The purpose of it was to develop the software for a product, designed for the Chilean context. The initiative did not work out the way they planned, not necessarily because of lack of local capabilities or human resources, but rather because of management difficulties and other practical challenges. It was mentioned that communication and language are important barriers to overcome in these research projects, especially due to the demands and necessity of documenting and formalising research activities. In sum, the project was not thought-out well enough before they decided to establish the unit.

We see that perceived costs and risk are important aspects of internationalisation of R&D decisions. Although one company seemed to have moved from a national treasure to a market-driven R&D strategy (von Zedtwitz & Gassman 2002) with research and home and smaller R&D units abroad concentrating on adaptations to local contexts, this was still in an early phase.

External environments and innovative infrastructures

It is interesting to note that the lack of strong relations between public research and industry was seen as a major challenge to developing more Chilean-based R&D activities. The interactions between *universities and industries* are considered as fundamental in the evolutionary perspective of innovation systems and the double network structure of MNCs, in which subsidiaries in host countries develop relationships with external actors in their environment (Castellani and Zanfei 2006).

Additionally, the access to highly qualified personnel and perceptions of a critical mass (which means less vulnerability and dependency), are two factors that matters more than local differences. This viewpoint was strongly advocated by most interviewees in Norway, maintaining that these are particular strengths behind Norwegian aquaculture's innovative capacity. As seen, these linkages are not strong in the Chilean case. This confirms some of the points made in the OECD (2007) report of the Chilean innovation system. Here, it is claimed

that there are barriers and challenges to overcome in order to fully enjoy an innovative and interactive environment in many Chilean industries.

Interviewees in *Feed Company 1* and the *Farming Company* in Chile agreed that universities often lack the proper knowledge of the industrial reality, especially concerning scale and scope of activities. However, the interviewees also admitted that the companies sometimes lack the time and focus required to cultivate contact with academic environments in Chile. Some discontent and concern was also expressed regarding the availability of applied science in Chilean public research, by some interviewees seen as a result of the lack of contact between the academic and the industrial realities. These processes were considered vital for building innovative capacity in emerging economies.

On the other hand, the local R&D unit of *Feed Company 2* has created a better foundation for cooperation between local universities and the company, because of 'intermediaries' or 'gatekeepers' in the local R&D unit that facilitate these interactions. An R&D manager in *Feed Company 1* agreed that this might be a way forward, but still expressed uncertainty about the need for a separate R&D unit to communicate more efficiently with local universities.

The informants also emphasises initiatives from governmental institutions to provide funding for research and innovative projects in the Chilean salmon cluster. *CORFO, the Chilean Economic Development Agency*, has now taken a more active role in organising and coordinating much of the investments related to innovation in Chilean salmon farming. The general aim for the public institutions according to CORFO is to further assist the development of a receptive salmon farming community in Chile to become more engaged in innovative work. The interviewees were unanimously positive to the initiatives from the public sector to provide incentives for the private sector's engagement in innovative activities. They consider that public funding is something that will be even more fruitful and decisive in the future, given that innovative activities are taken seriously by the actors.

Cultural factors

Nearly every interviewee mentioned the cultural challenges in operating with commercial activities across national borders as important. According to them, it becomes even more difficult when it comes to research and other knowledge-intensive activities. Both Chilean and

Norwegian actors pointed out that the Chilean aquaculture industry lacks a culture of conducting innovative activities. The before-mentioned copying technology tradition in the Chilean salmon farming industry acts as a barrier for internationalisation of innovative activities. This is a trait that is closely related to cultural or idiosyncratic factor according to many interviewees.

Chilean economic policies have the last decades been quite liberal and free of governmental intervention at most levels. The policies have created good conditions for market mechanisms to act freely and spurring foreign investments, causing principally stable structures and growth for the industry. It is likely that the rationales of these liberal policies were founded on neoclassical economic perspectives, where the actors are described as rational agents seeking to maximize profits. It underscores the point made earlier by Arocena and Sutz (2000) on that most Latin American countries undervalue scientific knowledge and technological innovation.

The focus on cost and revenues and short-term thinking has not allowed long-term innovative initiative to fully blossom in the Chilean context, since it has been considered more as an expense rather than an investment. "It will take time to build up a culture of embracing research in Chile", as a manager in the *Farming Company* explains.

6 Concluding remarks

We have seen that the technological developments in salmon farming have led to an increased focus on knowledge and demand for higher competences. The role of knowledge and collaborative relationships has become more visible and complex than before. This is in accordance with the increasing maturity of the industry and technological development in general. Therefore it has been suggested by different interviewees that in order to fully make use of the possible advantages, there is a need for create systems and structures that support these processes to happen.

With the course of time, the advancements in the industry have demonstrated that there are increased requirements to knowledge bases and competences for international actors, whether they are located in Norway or Chile. This is emphasised e.g. in the statement from the director of the *Farming Company* that more research in Chile is needed in order to build of the local context specific knowledge, a type of knowledge that will be complementary to the Norwegian MNCs internal knowledge.

Both companies with Chilean R&D (Feed Company 2 and Research Company) seem to have taken into account the importance of using established expertise in Norway, in the Chilean context, given the special challenges the industry is facing. However, it must be clarified that these initiatives still are in a very early phase of development with many challenges. But nevertheless they serve as examples on how MNCs could contribute to build innovation capacity and become more integrated in the Chilean innovation system. Despite this, the empirical findings generally confirm that Norwegian MNCs in Chile do not perceive the possible benefits of establishing local research units within their own company as quite high enough yet. Some possible explanations are that here are too many deficiencies in the regulatory regime, low levels of Chilean R&D and traditionally weak linkages between university and industry. These are all vital factors for building the industry's innovative capacity.

In other words, the firms seem to be reluctant to take the first steps but welcome government initiatives warmly. The most important policy implication would therefore be efforts to facilitate a general improvement in university-industry relations. Since the firms seem to be very cost and risk conscious, increased direct or indirect subsidies may be needed. Another initiative would be to create new or improved intermediary organisations, e.g. applied research institutes and laboratories doing contract work but with a certain level of public basic funding. Norwegian companies have long experience in collaborating with such institutions. Finally, there may be something to learn from the before-mentioned programmes to attract petroleum companies to Norway – where the drilling rights were coupled with obligations to invest in R&D in Norway. Although the aquaculture firms are generally in favour of a "business-friendly climate", clear and stable political regulations are seen as an advantage. Perhaps a coupling of good localities and infrastructure with local R&D collaboration programmes would be a possible initiative?

The Chilean aquaculture industry is still characterised as production-intensive, rather than knowledge-intensive. However, the current situation with ISA, high density between farming sites, low degree of innovation and research in Chile, are hopefully factors that could spark a "seed of change" in the terms of applying processes and products that are well documented and founded in research. It remains to see how the industry along with the authorities can

build up a sustainable innovative capacity, which more MNCs can learn from and contribute to.

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