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System building for better policy alignment in the South: the case of salmon farming industry in Chile

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ABSTRACT

I. Introduction

In this global age, issues that developing countries confront are widening and increasingly complex due to intricate ways in which countries are interlinked. Due to such increased interdependency, catching up process of development countries is increasingly becoming susceptible to the external events. This requires the developing countries to have more resilience and flexibility in adapting to the changes that happen beyond their control. To achieve above, the systemic approach is considered beneficial because this provides a holistic view in policy formulation. The use of innovation systems (IS) became increasingly popular among international development community (such as OECD, UNCTAD, UNIDO and World Bank) as well as some bilateral cooperation agencies in this context as a useful 'focusing device' to

identify and effectively meet the policy needs in the South under such context.

The IS is composed of set of interconnected institutions, agents, organizations, and the linkages between them that together and individually contribute to the development and diffusion of new knowledge in the form of process or products. Although the benefit of adapting the IS approach is largely agreed for effective policy formulation, conventional IS approach may require some adjustment to be applied in the Southern context.

The purpose of this paper is to explore the new ways in which the IS can be used from the Southern context. The following section briefly reviews recent policy discussions and potential limits when IS concept is applied for developing countries. The paper particularly pays attention to the IS system building and transformation since conventional IS discussion tends to focus on its internal interaction among components but not on transformation process. The paper also tries to apply proposed integrated approach to the actual existing case, Chilean salmon farming, to see whether such perspective can provide the richer picture for policy formulation. The section 2 reviews the theoretical and empirical discussions related to IS approach and propose a integrated framework based on existing frameworks. The section 3 reviews historical evolution of Chilean salmon Industry in relation to integrated framework with the following section 4 to conclude.

II Theoretical discussions

2-1. Current discussion on industrial policy with relevance to IS approach

Recently, several studies on industrial policy for developing countries (Hausmann and Rodrik, 2006, Rodrik, 2008, etc) are presented to mark the importance of holistic approach towards policy. These studies suggest the characteristics of framework that are similar to IS approach. For instance, Hausmann and Rodirk (2006) emphasize the developing countries' need to transform structurally towards new activities building upon existing capabilities[1], path dependence. They also recommended the government to use 'open architecture' for decision making process so that public and private stakeholders would self-organize in order to reflect the public interests resulting in achieving legitimacy for their 'purposeful action'. In their opinion, the government is not capable to make 'ex-ante' decision neither on the activities to be promoted nor on the instruments to be deployed but describe this process as a slow and gradual "process whereby the state and the private sector jointly arrived at diagnoses about the sources of blockage in new economic activities and propose solutions to them" (Rodrik, 2006: 24). They therefore called the industrial policy in the present–day context as 'self-discovery' and 'on going learning processes'. These 'design principles' of industrial policy—'open architecture', 'self discovery', 'on going learning process' –share similarities with the IS approach which emphasizes on holistic and systemic approach with dynamic interaction among stakeholders. Nevertheless, these 'design principles' were not developed into the framework to be used as a tool for policy makers as exist in IS approach.

[1] "exploit existing capabilities by which we mean the markets, physical and human assets, norms and institutions that were developed and accumulated for other pre-existing activities. These capabilities will be useful to the extent that they are similar to the needs of the new activities in question (Hausmann and Rodrik, 2006: 12). "

2-2 Innovation system (IS) approach

An innovation system (IS) is composed of a set of interconnected institutions, agents, organization, and the linkages between them. The components of IS, together and individually, contribute to the development and diffusion of new knowledge in the form of process or products. In the core of the system are firms and knowledge institutions. The core of the system is placed in the framework conditions which are set of economic, social and political efforts. The frame work condition is considered as beyond the control of the core. The system looks at the interactions between and among the components that constitute the system as well as the framework condition to promote innovative combination of knowledge. NSI is "set of distinct institutions which jointly and individually contribute to the development and diffusion of new technology and which provides the framework within which governments form and implement policies to influence innovation process" (Metcalfe, 1995).

Figure 1

2-3 Critics on applying of IS approach to developing countries

Despite the fact that there is renewed attention towards IS approach applied to developing countries, the IS approach, particularly the conventional NSI has raised some questions of feasibility when applied to the developing countries context.

(1) 'ex-post' vs. 'ex-ante'— ***on going process***

Many country studies on innovation system stem from the 'ex-post' study on developed countries (Freeman, 1987, Lundvall, 1985, Anderson Lundvall, 1988 etc). These studies

describe and compare the function in the established system that is equipped with institutional and physical infrastructure with human resources. However, policy needs for developing countries are—'ex-ante'—to study how to build and direct functional system or "the direction of system construction and system promotion" (Lundvall, 2005:29). The needs for ex-ante study are felt even more strongly under the present-day context, when there is no clear path for development (Arocena and Sutz, 2000) and the process of development is complex due to the multiple flow of key resources—capital, human and knowledge—beyond the national borders.

(2) 'spontaneous'' vs. 'conscious' or 'unplanned vs. 'guided' — ***managed transformation***

The second problem stems from the assumptions of conventional IS approach. IS assumes evolution of system as spontaneous and unplanned which is largely influenced by its past, the 'path dependence' (Arocena and Sutz, 2000, Lundvall, 2005). However, what most developing countries need is to break away from the past or existing 'unproductive trap'. In other words, Southern countries need to brake away from 'path dependence' and transform structurally with *conscious* system building process (Lundvall, 2005). In such process, institutions play an important role in supplementing and *guide* the 'spontaneous' development of the system (Lundvall, 2005).

(3)'inclusive' vs. 'governed' —**governance and open architecture**

Third problem the conventional IS approach encounters is absence of tool to depict the power relationship. The learning process of developing countries, the core of the IS approach, is much influenced by the power relationships or governance structure (Lundvall, 2005). The existing literature demonstrates how absorptive capacity or learning entity can influence the catching up trajectory; however, it is considered that existing global regulatory institutions such

as IPR can over-rule the trajectory of knowledge acquisition. The conventional factors for catching up—such as absorptive capacity and learning process—can be managed by the national/domestic policy; nevertheless, these are increasingly coming under the influence of global governance through international regulatory framework and market integration. In uncertain and fast changing era such as today, the new policy tool is needed to map out actors in wider context to capture interconnectedness and on-going process of interaction and change—co-evolution process—within the system and among the levels where system reside. It is in this context that Lundvall (2005) mentioned that the relationship between/ among global, national and local system is under researched.

(4) 'components' vs. 'functions' — **What *does* than *is***

Fourth problem stems from the attention given to the *components* of system rather than the actual *function* the system. In many developing countries, the conventional innovation system approach are studied and implemented by establishing *organizations* or visible entity—such as R&D centers, Ministry of Science and Technology etc—but without bearing much success. This is due to the fact that such approach is not focusing on the functions of system nor *institutions* that enable organization to function in the system, applying the definitions by Galli and Teubal (1997). This view is shared with Liu and White (2001) who call attention to the shortcomings of NSI approach for not being able to address the explanatory factors at system level. In other words, it is not enough to look at presence of components in physical terms but need to focus on their performance (functions) in collective form.

Although IS approach provides holistic approach towards better policy formulation at national, regional and local levels, there are some shortcomings when these try to respond to policy need of developing countries.

2-4. Current discussion on new frameworks for system building

(1) Introducing the concepts and systemic thinking

The third part of theoretical discussion looks at socio-technical transition approach which emerged from the study of technological change towards sustainable development. These approaches are relevant for the discussion of IS approach in developing countries for following two reasons. First, socio-technical transition approach recognizes that innovation and diffusion of technology are both individual and collective act which will go through continuous reassessment—on going process of learning. This also admits that technological change would require wider set of actors through interactions in form of system or network to create the shared vision about the trajectory of its development. Second, the socio-technical transition towards sustainable system requires system to 'break away' from unsustainable 'lock-in' through building new systems. In another words it entails risk and uncertainty. The cases studied under conventional socio-technical transition theories often accompany with high risks due to the large scale investments (such as large scale energy system, as in Hughes, 1990, Walker, 2000). The above condition is similar with the developing countries where there is presence of high risks and uncertainty in braking away from unproductive 'lock-in' structure through building new system for new economic activities. Of course, this does not deny the use of existing capacity as stated in Hausmann and Klinger (2006); however, the exiting

knowledge needs to be utilized in the effective combinations.

There are some different approaches within the —socio technical approach. Here I look at functions of innovation systems, multilevel approach and transition management to assess the positive and negative features when these are applied to the policy formulation for the Southern countries.

(2) Function of innovation approach

In this approach, the success of environmental technology to emerge and diffused is considered to be strongly associated with type of activities (Edquist, 2005) or functions of the existing innovation system (Hekkert, et al, 2007, Bergek, 2008) in stimulating and supporting the development of new technology in order move away from 'lock-in' situation. Several studies (Galli and Teubal, 1997, Johnson, 1998, Johson, 2001, Bergek, 2002, Rickne, 2000, Bergek and Jacobsson, Carlsson et al, Edquist, 2004, Hekkert et al, 2007) list key activities or functions that system carry out based on empirical case studies. The common features of these studies are examined and are compiled by Berkgek et al (2008) into 7 functions as follows: (1)knowledge development and diffusion, (2)entrepreneurial experimentation, (3)influence on the direction of search, (4)market formation, (5)development of positive external economics,(6) legitimation and (7)resource mobilization. These are called as 'Functions of Innovation systems' or 'system functions' which extend the original IS approach and concentrates more on interactions which is "specific to one innovation system or 'shared' between a number of different systems" (Jacobsson and Johnson, 2000) thus opening to more flexible set of networks consist of several systems.

It is considered that the more of the listed 7 functions the system performs, more likely for the technology used in the system could emerge and diffuse to become dominant one (Hekkert, et al, 2007, Jacobsson and Johnson, 2000). These functions are considered to be useful for policy purposes in transforming the existing system to support sustainable technology in question because it is focusing not on the particular organization (i.e. such as training center for knowledge diffusion) but to the activities which can be vary (such as high turn over of labour, presence of multinationals etc). The concept of function is considered important for the catching up process of the South because many new industry/sector emerges without provision of conventional organizations or policy associated with functions listed above (such as higher educational facilities, regulations, promotion policy etc); however, in some cases, the systems still *do* operate. Jacobbson and Bergek(2006) explore applicability of system functions by examining existing cases of Chile, Brazil and Korea. They consider that use of system function can systemically map the achievements and act as a focusing device for improvement of systemic performance with long term trajectories.

Despite the above advantages in its application to the Southern context for defining industrial policy, there are some shortcomings. First, unit of analysis is Technological Innovation system in system of functions approach but this is not very clear and not commonly applied in the Southern context. Bergek et al (2008) explain that first drawing the boundary of analysis, TIS, is an 'on going process of discovery' through making *deliberate choice*, *re-evaluate* throughout analysis, *draw conclusion* and *communicate* to stakeholders concerned. The recursive process of identifying the boundary is appropriate for 'self-discovery' process but this should not necessarily limit the unit of analysis to the technological innovation system. Second,

function of system analysis relies much on internal functioning of selected the technological innovation systems (TIS). In other words, this approach leave out the important part of system transition, the impact of the external background—such as macro economic conditions, global institutions (such as IPRs)—that indirectly/directly affect trajectories of system development particularly in the Southern system.

Figure 2 System of functions

(3) Multi-level framework

The multi-level framework explains transitions of system or network (configuration) of stakeholders through observing the interplay of three different conceptual levels: 'niche', 'regime' and 'landscape' (Geels, 2002, 2005, Geels and Schot, 2007). In this approach, innovation system related to the incumbent technology is labeled as 'regime' while the 'incubation rooms' for emerging technologies (the novelties) are labeled as 'niches' and exogenous environment beyond the direct influence of stakeholders is labeled as 'landscape' (Geels and Schot, 2007). The central question in this model is to understand which circumstances enable a 'niche' to become part of existing 'regime'.

Figure 3 Multi-level approach

This approach complements the system function framework by opening the black box of selecting TIS. Furthermore, the framework enables to show the intricate way in which several Technological Innovation System, (TIS) are interlinked with each other. This concept also allows incorporating wider configuration of actors—perhaps not really connected directly under the system function framework—into the picture of system development. Furthermore, landscape, the macro context in which the regimes and niches are nested leaves room to explain

the sudden external shocks and contingency impacts often observed in Southern countries. The landscape is originally not intended to include the macro economic condition neither any types of short term changes[2] but only to include the slow and gradual social context. Nevertheless this concept deem to be useful in extending understanding system development in the Southern context.

Despite many aspects of the multi-level framework positively complement the system function framework—by providing the panoramic horizon (both historical and global) to observe wider range of stakeholders in three dimensional forms to enrich complex picture of interplay particularly paying attention to novelties—this intricate nature of system makes it difficult to apply to the policy sphere. This is particularly true as it does not address directly to the roles of each stakeholders nor strategies that might lead to the successful technological adaptation and diffusion to lead toward system transformation.

(4) Transition Management and integrated model

Kemp et al (2007) develop the idea of transition management stemming from multi-level framework. This concept intends to influence and 'co-evolutionally steer' the direction of change through working on all three levels through influencing visions, transition experiments and cycles of learning and adaptation through modulation in cyclical manner. The nature of this policy framework is to understand and manage the *selection process* of sustainable technology towards the *vision* of sustainability (Kemp et al 2007 emphasis added). Kemp et al (2007) claim

[2] Based on conversation with Frank Geels in May 21, 2009.

that this approach entail both bottom up incrementalism and top-down managerial planning and would enable for society to achieve the sustainable environment in a gradual and reflexive way with guided process of variation and selection in the conscious manner in creating vision and getting towards that vision.

In the transition management, both system function and multilevel framework can co exist integrated as the focusing device to steer in co-evolutional manner. The important contribution of transition management is the concept of vision creation. This coincides well with legitimation process of system of function. Smith and Stirling (2007) questions the approach of transition management from the point of inclusivity in decision making for directionality. This criticism, however, may have less relevance in the Southern context, particularly at the earlier stages of development. This is because many of developing countries are always subject to the governance from the North. In the other words, in many occasions, there is no space for discussion for inclusively in deciding the directionality. Nevertheless, one must also kept in mind that process of development is not only the 'catching up' phase but it must also follow the 'taking over' phase through creating strategic areas of competence as Germany and Japan did after the World War II. In this sense, inclusiveness of Southern actors needs to be enhanced through various strategic policies in the later stages of catching up. The integrated framework can be useful because this enable to clarify strategy for policy makers and practitioners by indicating the role of institution from functional perspective and lead the policy to steer the policy to 'countervail' the governance power from the North.

Figure 4 Transition Management

The diagram (figure 5) shows the integrated model developed by the author. Here, the 7 functions is embedded in the multiple level. The functions themselves are included because these are the features of 'network management'. The shadows in niche, regime and landscape indicate that there are several relevant regimes, niches and landscapes. The transition of system is explained in three levels of 'niche' 'regime' and 'landscape' while paying attention to the functions at regime level (Figure 5) to identify the bottlenecks and policy tools for different levels so that co-evolution process can be steered to consciously to build and transform system towards shared vision. The key of this integrated model is not to illustrate faithfully the complexity of transition but to identify key elements that are needed to steer at 'niche, 'regime' and 'landscape' level paying attention to the development and transformation of 'system functions' at 'regime' level. Hence, it is more policy oriented and can be identified as policy tool.

Figure 5 Integrated frameworks

Following section describe the evolution of Salmon farming industry in Chile to show how integrated model can enrich the understanding of structural transformation with evolution of non-traditional industry. There are many successful and failure cases for developing non-traditional export products in developing countries. Many studies seem to concentrate on the macro and micro economic factors in understanding the success factor. Nevertheless, it is hoped that using the integrated framework would enhance understanding of importance in systemic dimention.

III. Case of salmon industry in Chile

The Chilean salmon industry has demonstrated strong export growth since its commercial establishment in the mid-1980s. In 2006, this industry exported approximately 387,000 tons (38% of world share for farmed salmon) and earned $US 2.2 billion, making it the top exporter of farmed salmon in the world after Norway (SalmonChile, 2006) (Figure 4). As Salmon is not originally native to Chile, this success of non-traditional industry is considered as the interesting case of achieving structural transformation.

Figure 5 Production volumes of farmed salmon by major producing countries, 1990-2006

The case; therefore, will describe the development of Chilean salmon industry with attention to functions as well as three levels of multi level approach: 'niche', 'regime' and 'landscape'. This application is 'ex-post' to see if the elements occurred in the Chilean case can be better understood in the suggested integrated framework and how systemic resilience was established. In other words, the case may be able to explain determinant of successful and unsuccessful outcome of non-traditional exports by focusing on systemic aspects. Again, the aim of this empirical section is to see if application of integrated innovation framework for the South can improve the understanding of structural transformation process that took place in Chile.

3-1 Historical development of Chilean salmon industry

(1) Purposeful action in defining the Technological Innovation System: around the

1960s to 1973

The emerging period of salmon farming have much to do with the combination of strong 'purposeful action' by public sector at national level, natural conditions suitable for fish farming at local site and window of opportunity at the technique of fish rearing at global level. Salmon farming technique for commercial use was established in the 1950s. The government, sensing the potential for this industry particularly with given natural condition at local site in Chile, tried to explore the feasibility of creating salmon farming industry in Chile.

During this period, the government utilized both bilateral cooperation agencies (Japan, USA, Canada) and domestic public organizations for obtaining technologies and financing. Within the government sector, the Institute for Fishery Development (IFOP) acted as a central agent in experimenting with and assessing the possibility of salmon farming. IFOP's attempts were strengthened by the establishment of the Agriculture and Livestock Service (SAG) in the mid 1960s, as its Fishing and Hunting Division also made a systematic attempt to evaluate the feasibility of fish farming in Chile.

Despite the active promotion of this industry, activities of the private sector, of all forms, both local and foreign, were almost entirely absent in Chile for salmon farming. It is also important to mention that during this period, exchange rate for Chilean peso was set substantially higher than US dollar (De Gregorio, 1999). The high exchange rate during

this period made the start up of industry rather difficult due to the risk.

(2) Emerging niche: 1974 to 1984

This period is characterized with emerging presence of private sector. Several foreign firms such as Union Caribe (USA, 1976), NichiroChile (Japan, 1979) invested directly to start salmon and trout farming in Chile but only Nichiro Chile remained. The reason for Nichiro's decision was mainly due to external factors and not due to the attractive investment climate of the Chile at that time as there were no active attraction for investment from on the Chilean side[3]. The main reason for their investment was due to the drastic fall in supply of salmon due to Russia's implementation that banned salmon fishing within their 200-nautical mile territories located in the Russian Sea (interview with Nichiro Chile, 2004).

The price of salmon remained high during this time. The domestic high inflation rate also made short-term investment to this 'high risk / high return' business viable option for local entrepreneurs. With rather successful demonstration effect by Nichiro, the entrant domestic firms in the farming business increased drastically in the first half of the 1980s. The financial loan by the Chilean Economic Development Agency (CORFO), the government organization for the promotion of industrial development, was utilized for the development of local private sector.

[3] In fact, in 1984, one Norwegian firm sent a mission to Chile to explore prospects for salmon production but they decided not to invest in Chile directly but to operate through partnership with domestic firms because they discovered incidence of disease and the inadequate transportation system. This gave opportunity for Chilean domestic firms to learn the business through interaction.

During this period, the government agencies related to farming fishery re-structured. The government created the Office of the Undersecretary of Fisheries and National Fishery Service (SERNAPESCA) under the Ministry of Economy, Development and Reconstruction in 1976 (instead of the Ministry of Agriculture). The former organization was in charge of strategy and policy and the latter of implementation and enforcement. In 1978, the Fisheries and Protection Division of SAG replaced its Fishing and Hunting Division. Furthermore, the government created a local institution, the Local Government Planning Office (SERPLAC) that took part in supporting aquaculture development.

Nichiro brought not only caused the demonstration effect but also diffused new techniques to the local firms. Nichiro introduced a 'fish-pen' technique in which a whole process of rearing started to take place in a tank (cultivo abierto) instead of releasing to the river ('ocean ranching') (Achurra, 1997; Avila et al., 1994). This method was soon adopted by many Chilean companies including the one owned by Fundacion Chile (Claudio and Oporto, 2000; Avila et al., 1994; Achurra, 1997). This new method in fresh water was soon applied to the production in saltwater. Many other imitations and adaptation also took place at local levels. Through number of imitations and adaptation, salmon farming firms produced many products necessary for the farming – such as equipment, net pens, nets and fish feed; however was dependent on imports for crucial input, such as eggs.

Fundacion Chile, a private and non-profit organization, demonstrated the technical and

commercial feasibility of large-scale salmon farming in the country with its own firm. It also focused on research and the implementation of new technology for raising salmon, such as artificial reproduction, behavioural studies and breeding, as well as the creation and exploitation of new freshwater and seawater farm sites (Achurra, 1997; SalmonChile, 2004). Fundacion Chile collaborated with the local government planning office (SERPLAC) to test trial net-pen farms for different species like king, pink and coho salmon, and rainbow trout. In addition, it provided technical assistance to those interested in developing farming projects in Coho and often sold the technology to farms already in operation.

(3) Niche to Regime: 1985/6 – 1989

The number of local salmon farming firms increased from 36 firms in 1985 to 56 in 1987 and production soared. This was helped by the expanding international market. During 1985-6, salmon exports reached over US $1 million, allowing Chile to be recognised as a salmon producer in the world for the first time (SalmonChile, 2004). Harvesting methods started to improve, and fish handling, cold chain management and the mechanization of the extraction systems underwent important changes. Small incremental innovations, such as introduction of plastic bins or containers with thermal insulation, were also observed. A critical mass of the industry formed, and this brought changes in the industrial structure.

The Association of Producers of Salmon and Trout in Chile (APSTC) was established among 17 companies. This idea was first driven by Fundacion Chile with two main missions: first market research, and second establishment of a quality certification system

(SalmonChile, 2003; Achurre, 1997; SalmonChile, 2004). It is evident that, with the increase in exports, the positive external economy of collective action became necessary in the industry. In another words, the cognitive process as an industry started to take shape.

The government sector continued to support this industry but indirectly. For instance, CORFO supported the establishment of quality certification either financially or technologically through their schemes but the initiatives were led by the private sector (Maggi, 2002).

FundacionChile became active and expanded its activities in various fields. It organized multidisciplinary work teams in areas such as trout pathology and pen construction, with foreign and Chilean technical consultants. From 1986, it also started a cycle of international seminars on salmon farming in certain countries, which was repeated in 1987 and 1988. Fundacion Chile was foreseeing future needs of the industry and investing in R&D in advance.

(4) Consolidation of regime and new emerging niches: from 1990 to 1995

Although local salmon producers grew rapidly, 1991 and 1992 were difficult years for many producers. Two big markets, Japan and the US, started to buy less due to the high prices of Chilean salmon. As the industries soon realised the danger of relying too heavily on two major markets, 13 local firms[] got together and set up a joint venture company, Salmocorp,

[] These were Salmon Mainstream SA, Robinson Crusoe SA, Salmones Tecmar SA, Fiordo Blanco SA, Invertec SA, AntarFish SA, Cultivos Marions Chiloe, Ancar and Salmones Andes, among others.

to enter new markets[5]. This resulted in the expansion of new markets which contributed to the diversification of markets for Chilean salmon.

The external price pressures caused structural changes through increasing outsourcing. Consequently, this increased the number of suppliers and created agglomeration of local firms involved in the salmon farming business. For example, fish feed, net and net installation services, processing industries companies emerged in this period as new independent industries in salmon farming. In other words, the new potential niches, which may evolve into different set of technology are created in form of suppliers. Another change was the further enhancement of salmon farming techniques, especially in its crucial input, the eggs.

The Association of Salmon and Trout Producers created the Institute for Salmon and Trout (INTESAL), in 1995. This institution aimed at increasing the productive efficiency of the industry and aiming to work with areas that involved common interests and needed to achieve scale economies like sanitary, environmental and training aspects of industry. To establish INTESAL, the Association obtained financial support from CORFO.

While private sector developed with initiatives to enhance its competitiveness, the public

[5] In fact, markets in Latin America – Argentina (1991), Mexico (1992), Venezuela (1995), Colombia (1996) – as well as in Asia – Taiwan (1994), Thailand (1994), Singapore (1995), China (1997) (Maggi, 2002; SalmonChile, 2003) were opened in the 1990s.

sector put forward several regulations, in an attempt to effectively regulate this industry because the regulation of this industry cross-cut the normal jurisdiction. Law of Fishing and Aquaculture (LGPA in 1991), Regulation in use of littoral coastline (DS No. 475(1994). National Register of Aquaculture (DS No.499, (1994)), and the Regulation on Information of Fishery and Aquaculture Activities (DS No. 464 (1995), Basic Environmental Law (LBMA) (Law No. 19300) are the regulation passed during this period which put different public institutions in contact with one another. [1]

Several indirect government-funding mechanisms to support private sector were established during this period. These included: the Scientific and Technological Development Fund (FONDEF), the Fisheries Research Fund (FIP), the National Fund for Technological and Productive Development (FONTEC), and the Development and Innovation Fund (FID). These funds were not intended solely for the development of aquaculture, but quite a substantial amount was utilized for the development of aquaculture.

(5) Increasing resilience of regime with integration with global forces1996 to 2002

During the latter half of 1990s global level competition intensified in this industry. Merger and acquisition took place at global scale and major foreign firms (Norwegians and Dutch) started to invest in Chile. Chilean firms also merged decreasing the number of firms in the industry operating in Chile from 219 in 1997 to 79 in 2002 while production was still on increase. This increased the presence of global forces within the regions. Meanwhile

[1] There were: the Office of the Undersecretary of the Navy, the Office of the Undersecretary of Fisheries, National Fisheries Services (SERNAPSECA) the Hydrographic and Oceanographic Service of the Navy, the General Water Authority, the National Borders and Frontiers Authority, the National Commission for the Environment and General Treasury of the Republic. In addition, the police force of Chile was included within the controls established by the National Fisheries Service and Merchant Marine and Maritime Territory Authority to oversee compliance with the applicable regulations.

consumption of fish increased due to various incidents such as BSE, bird flu and widespread healthy consciousness at global level.

In 1997, the US, Canada and the EU accused the Chilean salmon industry of dumping. This external threat greatly troubled the industry; however, the process of going through difficulty consolidated interest-based network of individual firms into more stable collaboration among the salmon industry. The Association of Salmon Industries is said to have played the important role in resolving the problem of dumping.[7]

The above incident perhaps confirmed the positive externality of having larger network of related stakeholders to countervail power relationships at global level. In fact, the salmon industry started to take a more extended view of their industry. They were increasingly seeing themselves as a "cluster" including wider set of stakeholders. For example, the Association of Salmon and Trout Producers changed its legal name to the Association of Salmon Industries, and opened its membership to related industries such as packers, fish-feed producers, transporters and other services in 2002. Furthermore, at the international level, the Association of Salmon Industries (Salmon Chile) took the initiative of having salmon industries in the US and Canada to establish American Salmon (Salmon de las Americas: SOTA) in 2003. This is intended to facilitate the flow of information on many issues, one of which is the WTO and the campaign for farmed salmon against wild salmon.

[7] Numerous interviewees mentioned the significant role played by the Association in resolving the dumping accusation. Various suppliers often mention this incident as the motivation for creating their Association.

Fundacion Chile continued to offer technical assistance to the industry throughout a network of services related to the domestic production of eggs, fish nutrition, farm sites and processing plants, plus economic feasibility studies in the industry. However, its role substantially decreased in the salmon farming industry as it reached to the matured state.

Government strengthened its role in the coordination of the aquaculture sector during this period. Due to the high investment and export potential, the government officially recognised aquaculture's potential as a future leading export sector. Government increasingly apply private-public collaboration in policy making, monitoring and establishing regulations. For instance, designing a National Aquaculture Policy, monitoring Clean Production agreement and establishing new regulations such as, Environmental Regulations for Aquaculture (RAMA in 2001) as well as regulations of measures for the Sanitation Regulation for Aquaculture(RESA in 2002) are done through some sort of private-public collaborations.

(6) Enhancing Resilience

During this period, Chile's policy of 'not having policy' shifts towards more guided approach towards creating strategies for competitiveness through enhancing capacity to innovate. Series of policy attempts to enhance innovation, research and development capacity were initiated during this period. For instance with funding from World Bank (2003-2009), Chile created research centers that support collaboration between university

and industry. In 2007, aquaculture including salmon farming is selected as one of the five priority areas for innovation in the report submitted to the National Commission for Innovation for Competitiveness[8]. In 2008, law was formally approved to give tax incentives for firms who hire universities or research centers to conduct research and development. These series of incentives resulted into the establishment of new units in university dedicated for the university-industry collaboration. Furthermore, these measures are set out to sent the positive signals for labour market so that current students would opt or scientific subjects.

At the industry level, Chilean salmon farming industry is becoming acutely aware of the fact that there is now no one ahead of them to 'catch up' through imitating the solutions for their problems. They have realized that they have to create and search for new ways to solve problems to improve and sustain their competitiveness (Aqua.cl, 10 Oct 2007 also interview). In other words, stronger consensus had emerged among industry for long-term investment on innovation for competitiveness to search for its own trajectory for future development.

The way in which the industry confront crisis can demonstrate the strengthened collaborative systemic approach. In 2007, there was an outbreak of diseases infectious salmon anaemia (ISA) and Sea lice that created substantial damages to the industry and in following 2008 the economic crisis happens to damp the demands in the markets. These require yet stronger

[8] In 2005, with the approval of the law that allocate certain portion of royalty income for copper towards investment on innovation, research and development, government announces it intention focus on the innovation capacity of the industry. This materialized first in creating the institution called National Commission for Innovation for competitiveness. The commission is established to make national strategy such as to prioritize area of investment towards innovation. In 2005-7 under the scheme of InnovaChile and CORFO, cluster development support was made and again, Salmon cluster was one of the first to be supported.

collaborative efforts using global knowledge.

For instance, when the ISA crisis hit the industry, the six largest salmon industrial firms in Chile(G6[9] (groupo de seis)), emerged and incorporated a sector-wide control system for preventing high-risk fish disease (Aqua.cl, 21 Nov and 11 Dec, 2007). G6 took the initiatives in sector-wide control of effluents of the processing plants, coordination of production, improving the quality of smelts and incrementing the bio-security of the cultivation centre. Furthermore (one of the G6), Skretting, organised a seminar on fish health in Chile sourcing the available knowledge on issues from both local and global levels. The industries are also self imposing the new norms—such as diminish the density of cultivation to avoid risks (Mercurio, 30 Nov, 2008).

In line with above activities by the industry to encounter the ISA as well as current economic crisis, the government announces plan to activate the salmon industry in Chile through providing better financial support, improving the regulative framework and institutions and stimulating the Research and Development in this sector in solving this problem scientifically (Aquachile nov. 28th 2008). The plan also provides Chilean government to provide financial guarantee loan through CORFO when private firms apply for the loan to invest in the new infrastructure, water treatments and environmental management. The

[9] These are Salmones, Mainstream, Salmones Multiexport, AquaChile, Camanchaca, Los Fiordos and Marine Harvest. The six firms are the largest salmon producers in Chile; at the same time, these are the most locally and internationally integrated firms. The four Chilean firms are dynamically exporting to the global market and two are owned by multinational firms (Mainstream, by Cermaq of Norway and Marine Harvest, by Skretting of the Netherlands).

loan guarantee was extended to small scale fishery in extending their aquiculture activities. As for the regulatory framework, the government and private sector will try to improve the environmental and sanitary regulatory framework such as introduction of eggs, use of antibiotics and introducing the concept of '*barrios'* (neighborhood) to integrate the system of concession for the farming site under this concept to rest the farming place in rotation. Furthermore, the government took initiative in R&D to prepare some fund for investigation on genome of salmon to improve the species together with Norwegian and Canadian government.

3-3 Integration:

The above history is summarized in the table (table 1) below. The case is mapped on the integrated framework based on 'system functions' 'multilevel approach' and 'transition management'. The complementary use of three approaches seems to fill the gap to explain why certain policy succeeded (though it is not possible to show why other did not work). It can also demonstrate the system transition process where the system emerges, establishes and gains resilience.

Table 1

At the early stage of system building in developing countries, the policy outcomes are strongly influenced by the 'landscape', the condition that the developing countries have no direct influence of. For instance, during the period from 1960s to 1973, government efforts in promoting salmon farming through bilateral cooperation created necessary knowledge base but

these were not enough to stimulate the entrance of private firms. The investment of Nichiro(Japanese firm) was caused by the Russian execution of 200 nautical miles which restricted Japanese supply of salmon and made Japanese firm to seek for new supplies in Chile. This created a demonstration effect to local firms to enter into the salmon farming while the high inflation rate in Chile favored high-risk high-return investment by local entrepreneurs. Such actions were also supported by yet another external condition, high international price for salmon.

Following period from 1974 to 1989, the industry expanded. The Fundacion Chile and Nichiro diffused knowledge and government supported these efforts by allocating resources so imitation took place at local level. Nevertheless, these were not possible if there were no expanding international market for their exports at the 'landscape' level. The case clearly demonstrates that, until the Chilean salmon industry became the 'regime' in around the mid 1980s, the 'landscape' conditions strongly influenced its development process and system building. In other words, the national level policy at its early stage requires placing much attention to what is going on at global level and flexibly and dynamically adjust its policy accordingly. This resonates with the 'open architecture' of Rodrik and Husmann(2006).

Once the industry establishes as the 'regime', in other words, when the system starts to perform 'system functions', the system start to gain some resilience against what happens in the 'landscape'. There are some outstanding developments by the Chilean salmon farming industries in the latter stage as it becomes the 'regime': the increase in collective activities

among private sector as well as between private-public institutions to enhance its resilience (countervailing power) against global shocks and increasing inclusivity in decision making process at global level through participating in the much wider collaboration networks.

The collaborative activities among private sector can be observed through various activities. The collaborative activities among firms increased its sophistication as the industry and tried to encounter external as well as local shocks such as price pressures, dumping accusations and introduction of new regulations. In each case, the firms increased their resilience through: outsourcing via creating local supplier-producer relationships, collective marketing and standardizing via creating associations and increasing predictability and reducing investment risks via private-public collaboration for determining and implementing national regulations.

The activities to increasing inclusivity in decision making process gradually take place as the regime tries to shift from the period of 'catching up' to 'taking over'. For instance, Chilean salmon industry association created external channel of communication with American and Canadian producers through establishing Salmon of Americas (SOTA) to negotiate issues of standardization at superregional level. Furthermore, searching their own science and technological solution for specific problems through using both global and local network of knowledge, as seen in the example of ISA, also change the position of Chilean salmon industry in the knowledge governance. The cumulative actions as above would increase the inclusiveness in determining the trajectory at landscape level.

In other words, at the early stage of catching up, a ‘regime’ is established either by coincidence or governments’ careful alignment of ‘purposeful action’ to meet the conditions at the ‘landscape’ with existing ‘niche’. These ‘landscape’ conditions can vary from behaviors of foreign investors, international price of salmon to changes in global regulatory framework. The key for policy formulation at the early stage is to have the holistic picture at ‘landscape’ level while paying careful attention to the ‘niche’ of its own so that policy can capture the window of opportunities and able to achieve the synergic effect with the external resources (capital&knowledge) to initiate the transformation process. In the latter stage of catching up, policy should focus on enhancing resilience of system through collaborative works and extending its knowledge networks.

IV. Conclusion

The renewed attentions towards industrial policy (Rodrik, 2007) called for structural transformation in developing countries based on: existing strength, private-public collaboration, open architecture and participation of networks of stakeholders. The process of change is ‘self-discovery’ and ‘on-going learning’ where government plays a crucial role. These ‘design principles’ of industrial policy make resonance with the IS concept based on evolutionary economics. The conventional IS approach was criticised from the Southern perspective; nevertheless, the emerging frameworks from the study on sustainable technology seem to complement the missing elements that are needed to understand the system building process of the Southern countries.

The case of Chilean salmon industry is examined to understand the process of building

innovation system from historical perspective. It showed that the system building, especially for the Southern context at the earlier stages, is very much influenced by the external factors. The presence of public support is important but that alone may not induce private entrepreneurs to invest and steer towards structural transformation. The success of policy lays in how to coordinate and align the elements at different levels.

The historical review of Chilean salmon industry also demonstrated sequential policy needs for system building. At the beginning of system building (niche) in developing country, it is possible to say that landscape level have rather substantial impact. The 'niche' is usually protected until the window of opportunity opens up. Hence during this time, strong 'purposeful action' is required by the government particularly to build necessary knowledge base, human resources and infrastructure. But at the same time, 'purposeful action' alone would not make successful system building. Such actions need to be accompanied with careful understanding of what happening at the 'landscape'. The transition period from 'niche' to 'regime', the policy needs to identify and encourage the self-organizing forces among stakeholders in the network with enough provision of knowledge flow. In many cases, developing countries, during this stage, do not have to create market at initial stage. This is due to being in the 'catching up' stage of development where the window of opportunity provides with the expansion of market at the landscape.

Once the 'regime' is established, the 'system function' approach can become useful in checking and identifying the bottleneck to consolidate the transition process from 'niche' to 'regime'. For

instance, in case of Chilean salmon industry, Fundacion Chile was the key actor for knowledge creation and diffusion. The 'regime', through identifying and complementing the bottlenecks, reduces the risks and uncertainties resulting to the increase in resilience against external shocks at the level of landscape. This requires the caching up countries to be included in the decision making as well as vision creation and consensus building process to steer the direction of influence of trajectory. In the Chilean case, the Association acted as the pathfinders for searching solution through interacting with networks of actors at horizontal as well as vertical level as it did for dumping accusation. The recent Chilean government policy for emphasizing innovation in the area of aquaculture can be considered as the extension such action with more public-private partnership.

This paper explored alternative framework for policy makers in developing countries to cause structural transformation. The aim was to integrate available frameworks to complement the existing IS framework to be more applicable to developing countries. As this case study was ex-post, much of the outcome could have been the lucky coincidence with some good policy balance. However, the case study suggests that the framework can improve understanding of the success of certain policies in the specific context so that policy makers can identify key elements and bottlenecks in the Southern country to achieve successful policy outcome. The success factor is not only in the market nor in capacity of firms but also in the open architecture of system which enable to align the networks of stakeholders to steer the trajectory of its development.

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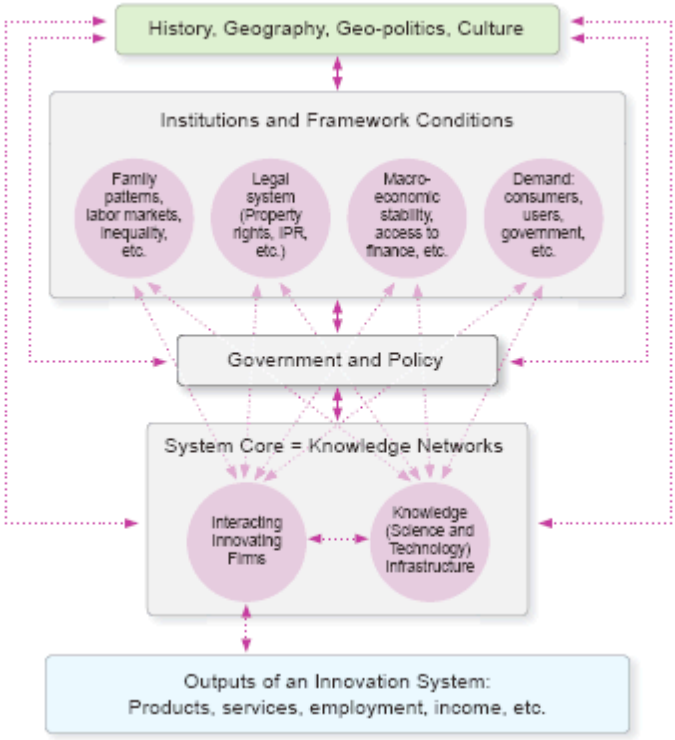


Figure 1 Innovation system

Source: UNIDO, 2008

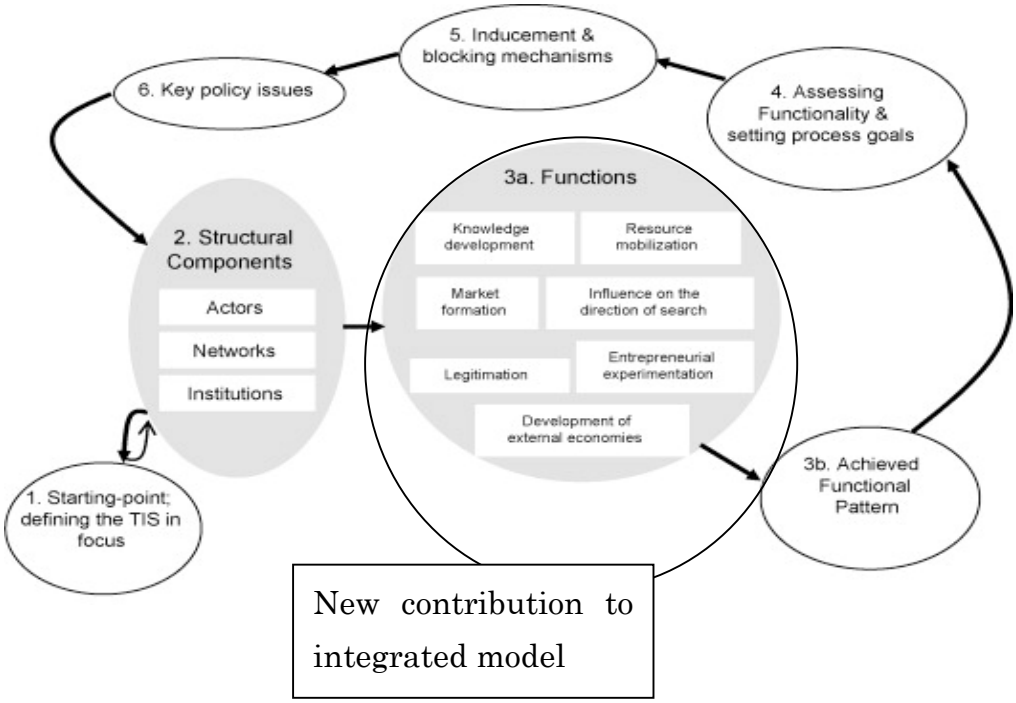


Figure 2 System of Functions

Source: Oltander and Perez Vico, 2005 quoted in Bergek et al, 2008.

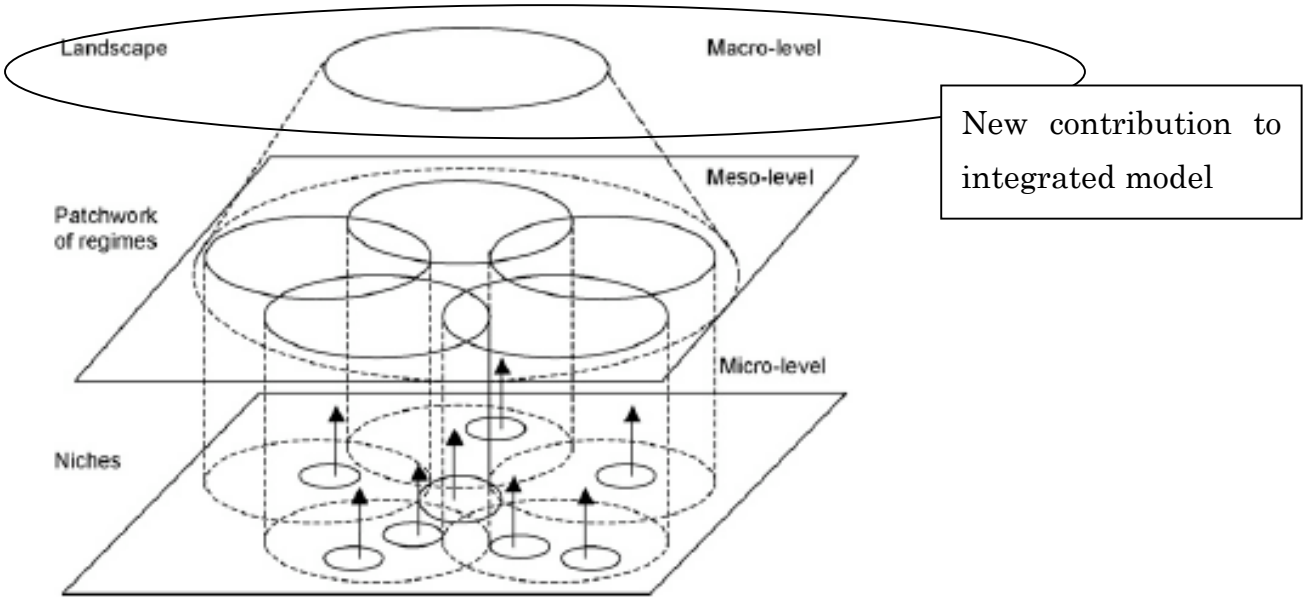


Figure 3: Multi-level framework for the analysis of socio-technical transitions

Source: Geels, 2004

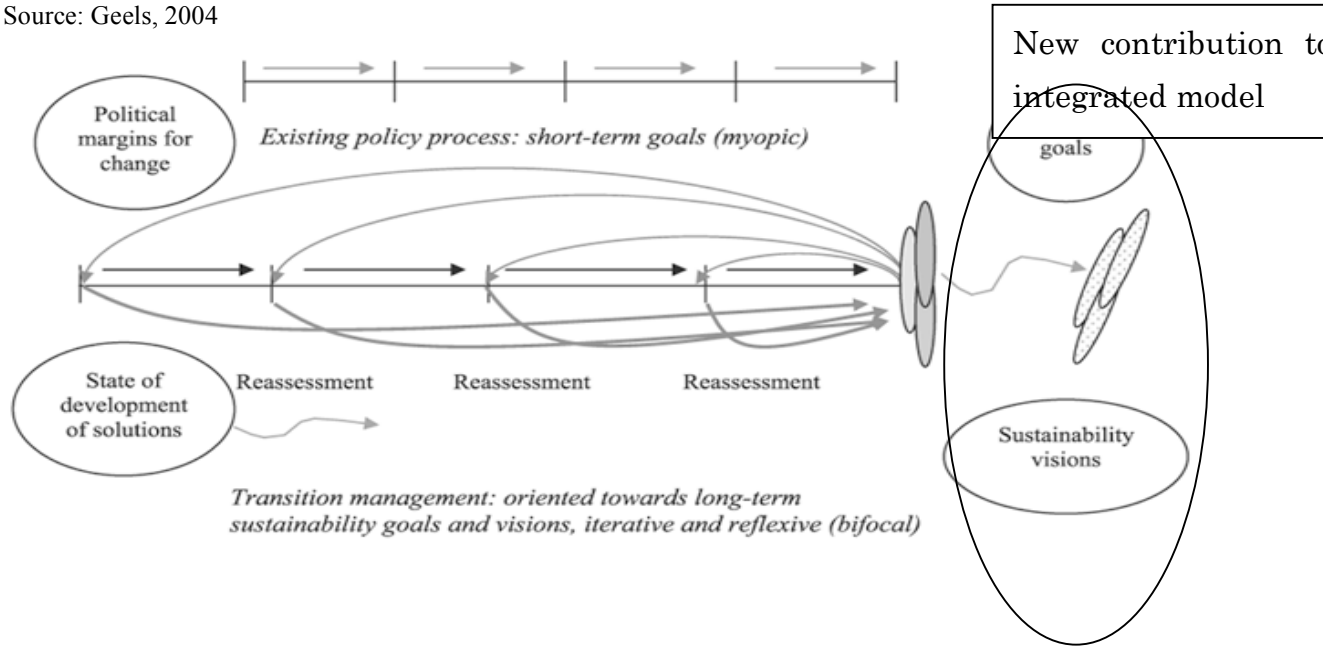


Figure 4: Transition Management

Source: Kemp, 1998

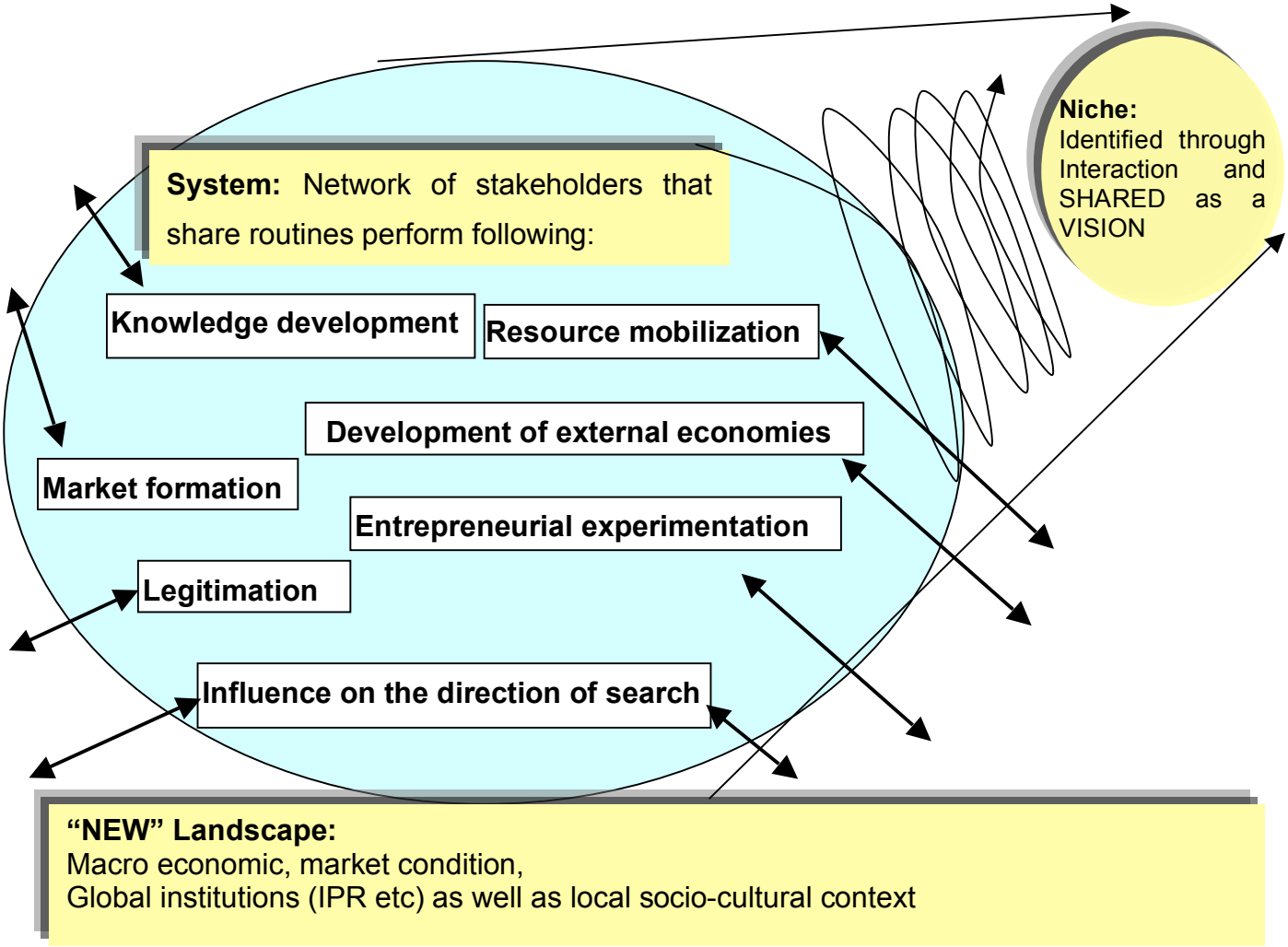


Figure 4: Integrated framework

Source: author

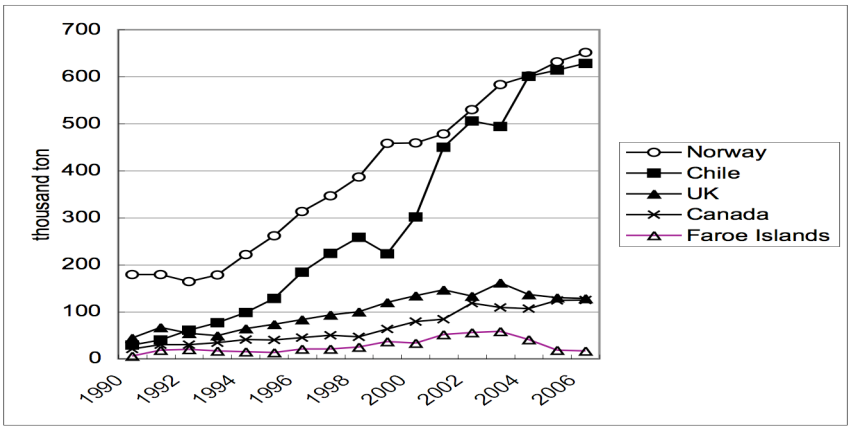
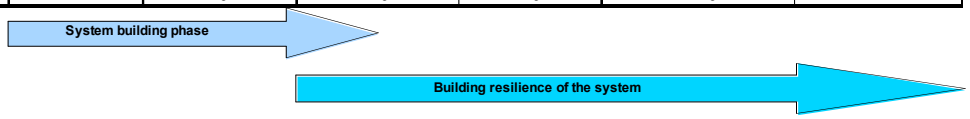


Figure 5 Production volumes of farmed salmon by major producing countries, 1990-2006

Source: Salmon Chile 2007.

Table 1 Summary of historical evolution of Chilean salmon industry

Functions it played		1960s-1973	1974-1985	1986-1989	1990-1995	1996-2002	2003-
Knowledge development and diffusion	Actors	Bilateral agencies, Government	Foreign Firm (Nichiro), local firms, Fundacion Chile, bilateral agencies	Fundacion Chile, Local firms,	Local firms; INTESAL and Associations	Local firms, Fundacion Chile	Private sector(G6), Universityfesearch cente; government
	Activities	Feasibility study, human capacity development	Diffusion of new techniques; limitations and adaptation; implementation of new technology	Research and experimentation and diffusion of knowledge; development of supporting activities, incremental innovation through imitation and adaptation with local resources	Introducing new equipments and technology; Increase productive efficiency	Introducing new knowledge and technology; technical assistance	Drawing necessary knowledge from various sources at global and local levels, Research and innovation; policy to support innovation
Entrepreneurial experimentation	Actors	NONE	Foreign firm (Nichiro) and local firms	Local firms	Firms, Salmocoop, suppliers	Local and foreign firms	Private and public sectors
	Activities	NONE	Producing farmed salmon; entering new areas through imitation	Expanding production	Outsourcing, marketing,	Merger and acquisitions (M&A), clustering, creation of associations	Research and innovation, knowledge collection
Influence on the direction of search	Actors	Public institutions (FOP and SAG)	Nichiro and local firms; government agencies	Association, Fundacion Chile	Government institutions	Associations, Government	Big private firms with global linkages, Private and Public collaboration
	Activities	Assessing the potential for fish farming	Actual production and entering into the business; restructured and strengthened to support the industry	Marketing and standards setting; searching technology and diffusion	Establishing regulations to remove duplication	Regulations and private-public collaboration	Sourcing knowledge, elaborating innovation policy, promoting strategic research
Market formation	Actors	NONE	NONE	Association	Salmocoop, suppliers	Private firms	Cluster of private firm
	Activities	NONE	NONE	Market research	Market creation, internal markets for salmon related goods	Creation of suppliers	Sustaining market through innovation
Development of positive external economics	Actors	NONE	NONE	Association	Salmocoop,INTESAL	Associations, Cluster of Salmon, Salmon of Americas	Private firm cluster
	Activities	NONE	NONE	Market research and standards setting	Marketing; R&D,	Competitiveness building; negotiation and participate in decision making	Research and innovation for further value added
Legitimation	Actors	NONE	NONE	Fundacion Chile, Local firms	INTESAL, government institutions	Association	Government
	Activities	NONE	NONE	Diffusion of Technology	Better management of fish	Consolidating as salmon cluster	Government policy to support research and innovation in emerging successful sector for longer time frame
Resource mobilization	Actors	Bilateral cooperation between Chile and USAID, JICA, CANADA	Individual entrepreneurs, Government agencies (CORFO), bilateral co operations	Government (CORFO)	Government agencies	Government funding mechanism, foreign firms	Private firm and government
	Activities	Human resources training	Investment; financing for investment; human resource development	Financing for collective activities	Financing mechanisms for research and technology sourcing	Research and development; FDI	Research and innovation
Path finder/key actor in leading the direction of development		IFOP, SAG Fishery sector	Nichiro and local firms (entrepreneurs) and Fundacion Chile	Fundacion Chile, Associations, CORFO	Private firms, Association	Association, private sector and some support from public sector	Private sector-Public sector-Research institution
Multilevel perspective							
Macro/landscape		Technology for fish farming develops as the new technology to resolve fish shortages(window of opportunity), High exchange rate for Chilean peso	1977 200 nautical mile agreed between Russia and Japan. Japanese fishery lost the salmon fishery ground and seeking for alternative supply. Price of salmon maintained high inflation rate in Chile.	Market expansion for farmed salmon; increasing requirements on sanitations at international markets	Trade liberalization progressed and foreign direct investment started to increase; Price of salmon goes down	Dumping accusation; Consumption of fish increase in general due to various reasons such as BSE, Bird flu, Health conscious. FDI increases during this period. Expansion of salmon farming ground restricted in Norway for the fear of sustainability issue	Food, energy crisis, commodity boom, Raise of China and India
Regime		Extractive fishery or any other existing economic activity	Extractive fishery or any other existing economic activity	Salmon farming started to become a regime	Salmon farming industry	Salmon farming industry	Salmon farming industry
Niche		Salmon farming	Salmon farming		Supplier of input and	Supplies of input and services	Suppliers of input and services
Cognitive process		Potential for aquaculture recognized among public sectors	Shown the production can be done through demonstration. "high risk high return" short term investment	Some collective actions needed to gain the group benefit	Better to meet the quality standards for better price. Increase value added more ingained among the industry	Sustainability of business in long run. Eliminate risk and uncertainty through building networks.	Building capability to be competitive. No longer catching up but creating new path for further development.
Productivity(needed input for output)		No data	4kg	2.8kg	1.7kg	1.3-1.25kg	No data



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