Original Article

Using Functions of Innovation Systems to Understand the Successful Emergence of Non-traditional Agricultural Export Industries in Developing Countries: Cases from Ethiopia and Chile

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Abstract Development of new export industries provides an important stimulus for economic growth and structural transformation in developing countries. In any country, numerous new export industries, whether initiated by the government or private sector, are always being pursued, but only a few become successful due to inherent uncertainties in new activities. In this paper, we adopted the functions of innovation systems framework to understand the process of system building through examination of the successful emergence of two non-traditional agricultural export industries in developing countries, namely the Ethiopian flower industry and the Chilean salmon industry to identify effective policy measures in the early phases of development.

Le développement de nouvelles industries exportatrices fournit un stimulus important pour la croissance économique et la transformation structurelle dans les pays en voie de développement. Dans n'importe quel pays, de nombreuses nouvelles industries exportatrices, soit lancée par le gouvernement ou par le secteur privé, sont toujours poursuivies, mais seulement peu d'entre elles réussissent dus à des incertitudes inhérentes dans de nouvelles activités. Dans cet article, nous avons adopté les fonctions du cadre de systèmes d'innovation pour comprendre le processus de génération du système par l'examen de l'émergence réussie de deux industries exportatrices agricoles non traditionnelles dans les pays en développement, à savoir l'industrie de fleurs éthiopiennes et l'industrie du saumon chilien, pour identifier des décisions politiques efficaces pendant les premières phases du développement.

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Introduction

Exports play a critical role in economic growth and structural transformation via diversification of economic activities. Voluminous cross-country empirical studies have shown that export diversification has considerable explanatory power in per capita income growth (see, Greenaway and Sapsford, 1994 for extensive review). Many developing countries have attempted to diversify export product bases to achieve better economic performance, but only a few have succeeded.

Policies for export diversification nowadays strongly resemble industrial policy (Pack and Saggi, 2006) in covering the creation of new productive activities extensively. It is now evident that building a new export industry requires development of new networks consisting of workers with specific skills, a set of intermediate inputs, logistics, procurement and marketing

systems, as well as sector-specific regulatory institutions, such as quality standards (Hausmann and Rodrik, 2006). This demands policy interventions to shape, (1) technological capabilities of individual and firms and their rate of learning; (2) the economic signals and market expectations (including on profits and opportunity costs); and (3) the way agents interact with each other and with non-market institutions for better knowledge diffusion and innovation, which in turn may lead to structural transformation (Cimoli *et al*, 2010).

The present paper applies the systems of innovation perspective and specifically the 'functions of innovation systems' framework (Bergek *et al*, 2008a; Hekkert *et al*, 2007) to analyze how new non-traditional export industries are fostered in developing countries based on two successful cases, namely the Ethiopian flower industry and Chilean salmon farming industry, which have become the world's 7th and 2nd largest exporters in their respective fields. Both are agricultural activities but involve highly sophisticated technical and organizational skills and knowledge, thereby resembling manufacturing industries. Ethiopia and Chile have natural conditions highly suitable for production of each product, respectively, and therefore development of these products can be considered to follow comparative advantage confirming strategies (Lin and Chang, 2009).[1] Nevertheless, these conditions alone cannot guarantee the successful development of export industries. In fact, both industries commenced with government interventions to start export activities in the 1960s (Chile) and 1980s (Ethiopia). Results from these interventions took a long time to materialize in terms of shaping the industry. For example, in both cases, the first pioneers (entrepreneurs) appeared a decade after the initial ('unsuccessful') interventions, with 'take-off' of exporters occurring after two decades.[2]

The case studies here are based on a survey, interviews, and secondary sources of information. The Ethiopian case is based on a two rounds of census-based surveys conducted in 2008 and 2010 with high response rates[3] and some additional interviews with key stakeholders in the sector. The Chilean case relies on a survey conducted with related actors in 2004[4] and secondary information from interviews with key stakeholders in 2009 and 2011 (see Appendix Tables A2 & A3).

The following section presents the analytical framework; Sects. 3 and 4 provide case studies and Sect. 5 draws the main lessons from the two cases using the framework.

Conceptual Framework: The Functions of Innovation Systems

The classical justification for interventions to support export diversification is to remedy 'market failures' that are exemplified as information asymmetries, underinvestment in knowledge, and externalization of negative costs caused by exploitation of resources. This approach, however, leaves out policy spaces where systemic efforts are required among various stakeholders such as industry, government, universities, and infrastructure just to mention a few (Cimoli *et al,* 2010). The systemic approach becomes very important, in this context, in outlining the networks of actors to complement 'market failures.' This approach, however, can also 'fail' (Klein Woolthuis *et al*, 2005) because each system component can either be too strong or weak to enhance creation of knowledge/innovation to stay competitive; requiring the coordination to prevent 'system failure.' Furthermore, neither 'markets' nor 'systems' are sufficient for determining strategic technological trajectories, because markets tend to follow short-term market signals while systems tend to follow the historical routine; causing 'transformative failure' (Weber and Rohracher, 2012). The justification for policy intervention, therefore, involves 'markets,' 'systems,' and 'transitional' failures.

The 'functions of innovation systems' approach (Bergek *et al*, 2008a; Hekkert *et al*, 2007) observes system-building process. By illustrating transitional processes with a systemic focus to allow policy coordination, this approach can complement not only 'market' but also 'system' and 'transformative' failures. Furthermore, the framework can support identification of effective types of interventions at the given moment of transition. The transition processes are illustrated through seven functions. These are 'entrepreneurial experimentation,' 'knowledge development and diffusion,' 'influence on the direction of search,' 'market formation,' 'legitimation,' 'resource mobilization,' and 'development of positive externalities' (Bergek *et al*, 2008a).

The functions approach has been applied to study the emergence of disruptive and strategic technologies[5] that require 'transitional' efforts, (such as renewable energy) in advanced-country settings (e.g., Germany, Netherlands, and Sweden) (Jacobsson and Johnson, 2000; Johnson and Jacobsson, 2003; Jacobsson and Bergek, 2004). In such studies, certain technologies (or technological areas) are 'pre-selected' as strategic sectors to be developed. The studies that apply this approach in developing countries focused also on diffusion of renewable energy technologies (e.g., van Alphen *et al*, 2008; Tigabu *et al*, 2015), except for the study by Jacobsson and Bergek (2006) that uses the approach to analyze the 'catch up' process of industries in developing countries where system building is critical for success.

The section to follow modifies functions for developing a non-traditional export industry in a developing country context.

Modifying the Seven Functions for Developing a Non-traditional Export Industry in a Developing Country Context

In developed economies, *'knowledge development and diffusion'* is a 'disruptive' process that goes through stages of 'emergence,' 'consolidation,' and 'maturity,' while in developing countries, it is 'adaptation' or 'imitation' with reverse learning that starts from 'matured technology' (Kim and Dahlman, 1992; Hobday, 1995). For developing countries, engaging in exports creates opportunities to stimulate learning via increasing interaction with global markets when given sufficient absorptive capability and technological efforts (Cohen and Levinthal, 1990; Lall, 2000; Kim, 1998). To 'catch up' they need to overcome (1) imperfect knowledge on alternative technologies; (2) high search costs for the right technology; (3) insufficient levels of absorptive capacity to use matured technologies. Once technology is imported, its efficient use requires adaptation to local conditions and creation of new skills to master its 'tacit' elements (Lall, 2000). Moreover, technological learning does not take place in isolation, but involves a range of actors and networks (formal as well as informal); the interactions among suppliers, competitors, customers, consultants, and technology suppliers as well as networks among industries, technology institutes, extension services and universities, industry associations, and training institutions are important, not to mention the provision of physical and legal infrastructure (Lall, 2000; Cimoli *et al*, 2010).

'Entrepreneurial experimentation' in developing countries does not refer to development of completely new products or processes, but mainly 'cost discovery' for entry into export markets (Hausmann and Rodrik, 2003). Entrepreneurs must work to 'discover' new combinations of available resources (i.e., natural, human, financial) in order to create comparative advantages in markets. However, absence of infrastructure (physical, legal economic, and social) makes engaging in new activities costly and risky. The presence of risk-taking entrepreneurs is critical for the successful emergence of new activities but due to the above conditions, risks can be higher for entrepreneurs in developing countries.

'Market formation' for emerging technologies and products (i.e., renewable technology) of a disruptive nature normally involves 'nursing,' 'bridging,' and 'maturing' the underdeveloped market (Bergek *et al*, 2008a). For developing countries to diversify exports, international markets for the particular product must already be present. *'Market formation,'* hence, refers to finding access to existing markets (Jacobsson and Bergek, 2006). This necessitates the overcoming of challenges such as meeting quality requirements for global markets and negotiating with global buyers for product specifications (i.e., traceability, standards, logistics) (Humphrey and Schmitz, 2004; Kessing and Lall, 1992).

'Guiding the direction of search' refers to factors that motivate firms to take risks in development of new export activities. New activities are associated with high uncertainty, which can be severe in developing countries, making firms reluctant to invest unless they are convinced of new business opportunities. Hence, growth potential and expectations for new activities requires not only export promotion and market signals but also systemic support, in particular, infrastructure provision.

'Resource mobilization' means the same in developed and developing countries with the difference being the magnitude of basic provisions in physical, legal, economic, and social infrastructure. Developing countries suffer particularly from the shortages of expertise, finance, physical infrastructure, and complementary services.

'Legitimation' refers to social acceptance and shared visions of the development potential of the sector or technology in question (Bergek *et al*, 2008a). Hausmann and Rodrik (2006) argue that legitimacy is the principal motivation behind public–private partnerships in the promotion of new activities. The legitimation of new technologies in developed countries is typically initiated by supply side factors (such as technological assessment) (Bergek *et al*, 2008b); however, export diversification in developing countries is typically motivated by the demand side – market signals (high demand or market niche). Sometimes, legitimation requires entrepreneurs to form advocacy coalitions to mobilize governments to equip sector-specific physical and institutional infrastructure.

Despite the difference of being determined by supply or demand side factors, the fact that the subject of study (areas of technology or product) being 'pre-selected,' makes this framework appropriate, to apply in the context of non-traditional export development in developing countries.

'Development of positive externalities' refers to externalities not only generated by agglomeration (Marshall, 1920) but also within networks that developed through related activities (Porter, 1990; Bergek *et al*, 2008b). This is because the increased presence of new entrants (1) reduces the initial uncertainties of future prospects; (2) provides more legitimation and strengthens the negotiating power of advocacy coalitions; (3) increases chances for new combinations to arise (Bergek *et al*, 2008a). In developing countries, advocacy coalitions play a critical role in negotiating provision of infrastructure by governments.

Observing the Early Phases of Development of the Export Industry

Along the industrial life cycle (Klepper, 1997), different 'binding constraints' will emerge, requiring distinctive policy interventions. We focus on two early 'industrial phases' of the industrial cycle: the formative and growth phases. The selection was made because initial systemic conditions are particularly challenging in developing countries.

Case I: The Ethiopian Flower Industry

Overview of the Industry

The Ethiopian flower industry is a successful case of export diversification in Africa. Figure 1 shows the cumulative number of flower producer/exporter firms and export values for the period 1995–2011. The entry process was slow in the early years. In the mid-1990s, two domestic entrepreneurs started establishing flower farms with the aim of exporting to the European market. Until 2003, there were only five cut-flower firms with a total export value of not more than USD4 million dollars.[6] This has changed drastically since 2003. In just 1 year (from 2003 to 2004), the industry demonstrated continuous growth, and the number of firms doubled (from five to ten). By 2008 the number of firms reached 81, an increase of a factor of around 16 compared to 2003. In the same period, the value of flower exports grew by about 26 times and continued to grow even faster in the following years. In 2011, Ethiopia's flower export value reached about USD225 million. This amounts to an annual average growth of about 47 per cent in comparison with the 2003 export value.

Despite its late entry to the global cut-flower market, Ethiopia is currently the second-largest exporter in Africa after Kenya. Cut flowers are now among the top five export commodities of Ethiopia that generate foreign exchange. The sector also has had a tremendous effect on employment and poverty reduction. The Ethiopian Horticulture Development Agency reports that the flower industry has created more than a hundred thousand jobs (directly and indirectly) out of which women (mostly from rural areas) account for about 70 per cent of the workforce. There is an emerging concern about the potential impacts of the flower industry on the environment (water, soil, and air pollution) and occupational health and safety of workers. As a response to this, the industry association, in collaboration with the government and international donors, launched a Code of Practice for flower production in 2007, which is in alignment with international standards such as Global Good Agricultural Practice (GAP). But some still argue that these standards are not implemented by many companies and also question whether compensation is adequate for evicted local farmers.

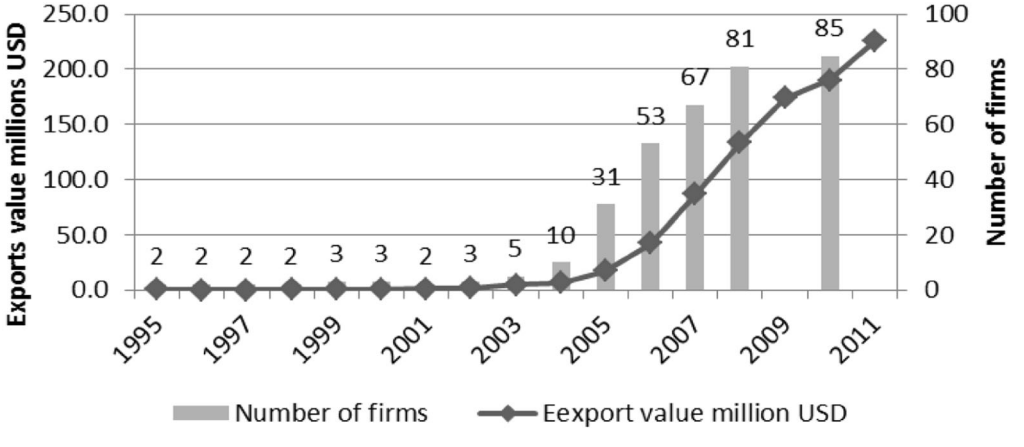

Figure 1: Pattern of exports and number of firms in the Ethiopian flower industry.
Source: For export value and volume, UN-COMTRADE; for the number of firms, authors' own survey.

Table 1 summarizes some characteristics of the flower farms examined in the survey. Foreign-owned firms (in the form of joint ventures or full ownership) dominated the sector starting in 2004, and by 2010 their share stood at about 72 per cent of the total.[7] A significant number of foreign firms came from other African countries such as Kenya, Uganda, and Zimbabwe. For example, firms such as Linsen, Abyssinia, Maranque, Karuturi, and Sher-Ethiopia (the largest company in the flower industry) came from Kenya. According to our survey in 2008, 33 and 23 % of foreign-owned farms rated climate and government support policies, respectively, as their primary consideration in their decision to invest in Ethiopia's flower industry.

The entry process and export growth suggests that the industry took off after 2003, so we consider 2004 as the year when the sector moved from the formative stage to the growth phase. Henceforth, the 'formative' phase for the Ethiopian flower industry refers to the period up to 2003 and the 'growth' phase to the period since 2004.

Mapping Functional Patterns: The Formative Phase

Entrepreneurial Experimentation and Knowledge Transfer: First Movers and Early Imitators

In Ethiopia, the first attempt to export summer flowers (produced in state farms) to Europe was made in the early 1980s, but this was not successful. Following the transition from a command to a market-oriented economy in the early 1990s, two domestic entrepreneurs took the initiative and started to produce flowers for export to Europe. In 1993, the forerunner flower-exporting firm, Meskel Flowers Plc, emerged, followed soon after by another firm, Ethio-Flora. Both firms produced summer flowers and were located in the lowlands. Meskel Flowers later started producing roses using a rudimentary wooden greenhouse. Both firms faced various challenges (including shortage of skilled labor, marketing knowledge, and inappropriate choice of sites and technology). With almost no government support, they eventually disappeared after five or 6 years.

Table 1: Characteristics of Ethiopian flower firms (numbers in parentheses are percentages)

	Year			
	2000	*2004*	*2007*	*2010*
Ownership type				
Domestic	2 (67)	4 (40)	24 (36)	22 (29)
Fully foreign	1 (33)	4 (40)	28 (42)	43 (56)
Joint venture		2 (20)	15 (22)	12 (16)
Total number	3 (100)	10 (100)	67 (100)	77 (100)
Main type of product (%)				
Roses			79.7	83.1
Cuttings			7.8	7.8
Summer flowers			12.5	9.1
Share of exports (%)				
EU-27 countries	(92)	(76)	(91)	(93)
The Netherlands	(12)	(26)	(70)	(84)
Sales channel (%)				
Holland auction			(54)	(55)
Direct sales			(44)	(42)

Note: The total number of firms at this time was 85, with 7 missing firms in 2010 survey.
Source: UN-COMTRADE; otherwise based on the authors' 2008 and 2010 surveys.

In 1999, Golden Rose Agrofarms Ltd (hereafter Golden Rose), a UK-based business, started flower production. Although Golden Rose faced similar challenges to the early entrants, it overcame these and became a pioneer in the sector. Before making its investment, Golden Rose thoroughly examined the performance of the early flower firms and decided to locate its farm in a highland area to produce high-value roses and use a modern steel-structure greenhouse. Moreover, Golden Rose overcame the skilled labor shortages in the domestic market by recruiting two Indian expatriates and began to train Ethiopian workers. Following the success of Golden Rose, four additional rose farms, three of which were established by Ethiopians, entered the industry between 2001 and 2003.

The technology needed for flower production was, by and large, available in the international market. During the formative phase, knowledge transfer occurred mainly through purchase of inputs, equipment, and expert services from abroad. The firms imported most of the equipment needed for construction of physical infrastructure (greenhouses, irrigation systems) as well as plant varieties through licensing from international breeders. Finding the right combination of cultivation sites, product type, and technology was not, however, straightforward. As indicated above, the first failed attempts were made to produce low-value flowers in the lowlands with rudimentary technology, while the successful Golden Rose chose to produce high-value roses in the highlands using a modern steel-structure greenhouse. Golden Rose and its followers, however, also faced an acute shortage of specialized labor. To resolve this problem, almost all the farms that started before 2005 recruited expatriates, particularly from Kenya or India, in parallel to providing in-house training to their workers.

Market Formation: Linking with the European Flower Market

As the primary destination for Ethiopian flower exports is the European Union (EU), the main task of market formation at this stage was to establish access to this market. Most early entrants started exporting through the Dutch flower auction because of easy access. But the firms had to overcome a range of marketing challenges, such as improvement of quality and handling methods; fluctuation of auctioned prices; and high auction facility service costs. This forced some early entrants, for example Golden Rose and Meskel Flowers, to shift their export channels from Dutch auctions to direct sales in Germany. Another barrier at the early stage was the lack of domestic complementary inputs and service providers such as agrochemicals, cool chain facilities, handling and forwarding services, and air transport. The early entrants had to deal with these problems individually until they formed an association to negotiate collectively with the government to seek its support.

Resource Mobilization, Legitimation, and Guidance of Search: The Beginning of Public–Private Partnerships

In its early stages, no government programs targeted the flower industry in Ethiopia. Consequently, the early entrepreneurs faced various constraints, including access to land, finance, and air transport. In order to address these bottlenecks, the existing five firms at that time organized themselves and formed an association, the Ethiopia Horticulture Producers and Exporters Association (hereafter EHPEA or the Association) in 2002. The Association negotiated with the government to seek support (i.e., to *mobilize resources* and *legitimation*) for the development of this industry. As a result, the government worked out a five-year plan of action for this sector and outlined the sector's constraints and possible solutions. It sets targets, for example, 1000 hectares of hectares of land to be covered by flowers by the end of the 5-year plan. To meet these targets it launched a multifaceted resource mobilization program, including improving access to land and long-term credit, as well as infrastructure and air transport

coordination. The government announcement of its engagement with the flower industry near the end of the formative phase sent a positive signal about the future prospects of the flower industry.

The Association was an integral part of the preparation of the first five-year government plan of action. The public–private partnership that has been built over the initial years helped to *legitimate* the flower industry. It facilitated consensus building between stakeholders and *mobilization of resources* necessary to scale up the sector activity and influence the direction of search.

Mapping the Functional Patterns: The Growth Phase

Knowledge Development and Diffusion: FDI as a Conduit for Knowledge Transfer and Diversification of Activities

In 2004, the number of flower firms reached ten, double the amount of the previous year, marking the beginning of the 'growth' phase. The majority of new entrants were foreign-owned, a trend that continued from this stage onwards, ultimately dominating the sector (see Table 1). The large inflow of foreign-owned firms helped to bring about a scale effect on the Ethiopian flower industry in terms of export quantity, diversification of activities, and knowledge transfer. For example, by 2008, there were six cutting firms owned by European breeding companies exporting young plants worldwide, as well as supplying the domestic market. The entry of Sher-Ethiopia, a subsidiary of Sher-Holland – the biggest flower producer in the world – was another case in point, illustrating the increasing role of foreign firms in transfer of technology and marketing knowledge.

The turnover of skilled workers has facilitated intra-industry knowledge diffusion. The high turnover of trained employees negatively affected some of the first entrants, for example, in the form of upward wage adjustment to retain skilled labor. As the sector grew, the pool of domestic expertise increased and the market for skilled labor thickened. Furthermore, the majority of firms conducted both in-house and external training for their employees, further accelerating knowledge diffusion in the sector.

Market Formation: Complying with International Standards

The major market destination for Ethiopian flower exports continues to be the EU. For example, in 2007, the EU-27 accounted for about 91 per cent of the total value of exports, of which about 54 per cent were channeled through the Dutch auction (see Table 2). The European market is, however, characterized by complex rules and standards covering a wide range of issues, from safety, quality of products, and labor conditions to environmental impacts.

Table 2: The role of government and the Association in resource mobilization, Ethiopian flower industry

	Source of land government lease	*Air carrier for exports – Ethiopian Airlines*	*Source of finance for initial investment*			*Participated in training provided by the Association*	*Have acquired industry code of conduct certificate*
			Own	*Development Bank of Ethiopia*	*Other domestic banks*		
Share (%)	83.0	87.3	52.3	33.9	4.6	87.0	81.8

Source: EDRI and GRIPS, 2008 and 2010. See footnote 3.

Hence compliance with standards became crucial for continued access to the EU market. Meanwhile, a sense of urgency has developed among stakeholders in the sector with regard to market diversification and development of industry standards.

Expanding export outlets and deepening access to existing markets required multifaceted efforts, among others improvement of product quality, logistical capability, human resource development, and adoption of international standards. These new challenges had far-reaching implications for strengthening coalition-building among various stakeholders, including the private firms, the government, and the donor community. Below, we explore this coalition-building by means of practical actions.

Resource Mobilization, Legitimation, and Guiding the Direction of Search: Coalition-Building and Consolidation of Flower Industry

In the growth phase, membership of the Association increased substantially and its activities broadened. The Association continued to play a significant role in the development of the sector in respect to coordination, advocacy, and capacity building.

In 2007, responding to mounting pressure for standard compliance, the Association, in collaboration with the government and donors, launched a national scheme of GAP known as the EHPEA Code of Practice for Sustainable Flower Production. The EHPEA Code is in line with internationally recognized standards such as Global GAP and MPS (Milieu Programma Sierteelt). To implement the national scheme and build the capability of firms to comply with standards, the Association organized a series of training programs for its member firms. The majority of firms participated in the training, and as a result about 50 firms (82 per cent) were certified with the industry code of practice in the period from September 2007 to March 2010 (see Table 2). The development of the code of conduct was a big step forward in improving the image of the Ethiopian flower industry (*legitimation*) and its market access.

Moreover, the Association has developed very strong connections with the international community and secured wide support for the sector. It has also been involved in building industry logistical capability and market diversification efforts through visits to potential markets, for example Russia, Japan, and the Middle East.

The government has also played a crucial role in mobilizing much-needed resources for the sector. First, the government persuaded Ethiopian Airlines to work in coordination with flower producers and exporters in the promotion of the sector with a long-term vision. As a result, 87 per cent of firms reported using Ethiopian Airlines to export their flowers in 2008 (see Table 2). Second, the government made land available for flower farms within the vicinity of the Addis Ababa airport on favorable terms. In fact, 83 per cent of farms leased land using this scheme. Third, Development Bank of Ethiopia (DBE) provided finance on generous terms for investors in the flower sector. To address the growing demand for skilled labor, the government partnered with the Association and donors to launch a long-term capacity building project in 2007.

Furthermore, the government assumed a regulatory role by supporting the establishment of industry code of practice, enacting new regulations to guide the use of foreign exchange from flower exports, and locational concentration of firms, as well as providing improved phytosanitary services. The government has started to formalize its relationship with the private sector. For instance, the Horticulture Development team formed in 2002 within the Ministry of Trade and Industry (MOTI) was upgraded and became the Ethiopian Horticulture Development Agency (EHAD) in 2008.

Development of Positive Externalities: Strengthening Complementary Activities and Collective Action

The early phase of the industry was marked by an under-development of complementary activities, including the absence of input suppliers and export facilitators, and the lack of cheap and reliable air cargo. Collective action in the form of association by the private sector was necessary to resolve the coordination problem. With the growth of the flower industry, complementary activities emerged, such as propagation of plant materials, packaging, fertilizers, and chemicals suppliers. Several international breeding companies also started to establish production sites in Ethiopia. As a result, inputs such as plant materials, fertilizers, and chemical products are gradually being sourced from local suppliers. Access to air transport has improved substantially in the growth phase due to the entry of foreign carriers (e.g., KLM, Etihad, Emirates), which have expanded their services, attracted by the growing market. The development of a skilled labor force is another positive externality. Follower firms were able to hire people with prior experience of working in this sector.

Case II: Salmon Farming in Chile

Overview of the Industry

The Chilean salmon farming industry is another successful example of export development. Salmon is not a native species to Chile, so the development of this industry started from scratch. The export of farmed salmon started in the early 1980s and by early 1990s, Chile had become the world's number two exporter. Chile is endowed with natural conditions favorable for salmon farming. However, these natural conditions alone did not make Chile a leading salmon exporter.

Chile initially benefited greatly from technical support from Japan (Japan–Chile Salmon Project) in the 1960s, when the public sector took the initiative to use a bilateral cooperation scheme. The technological transfer was later continued by the FundaciónChile in the 1970s. Such technological efforts prepared the knowledge base for the early entrepreneurs whose entry into this activity in the mid-1970s led to the emergence of the salmon industry in Chile. The industry has been significant in creating employment; about 8000 direct jobs and 2200 indirect jobs in 1992 to 38,400 direct jobs and 15,000 indirect jobs in 2004, mostly in the Southern regions where employment opportunities are scarce. As for the value of exports, the share of salmon in total exports grew from a negligible total in the 1980s to almost 4 % in 2008[8], right before the sanitary crisis[9]. In fact, during 1985–1986, the value of salmon exports reached over USD1 million. Since then, export revenue has increased exponentially, rising to USD2490 million in 2008, with the number of firms increasing from 36 in 1985, to 56 in 1987, 83 in 1990, 184 in 1994, and 219 in 1997 (Figure 2).

Based on the increase in the number of firms and export values, the development of the Chilean salmon industry can be divided into three phases: (1) 'formative': from the 1960s to the mid-1980s; (2) 'growth': from the mid-1980s to 2000; and (3) 'mature': from 2000 onwards (Iizuka, 2007). This study, for the purpose of comparison with the Ethiopian case, focuses only on the first two phases: the 'formative' and the 'growth.'

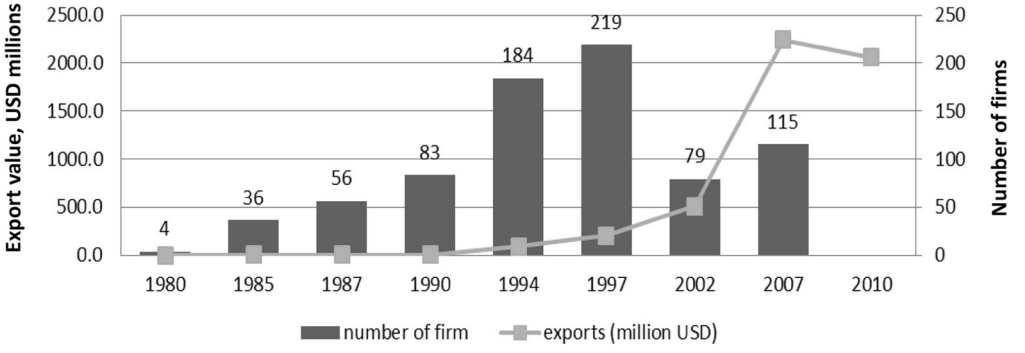

Figure 2: Growth of the salmon farming industry in Chile.
Source: SalmonChile (2003) and *Revista Aqua* (2010).

Mapping the Functional Patterns: The Formative Phase

Guidance of Search and Resource Mobilization: Public Support for Discovering Export Potential

In the 1960s, the Chilean public sector took initiatives toward guiding and allocating resources to promote the salmon industry. Government agencies at that time surveyed potential areas to evaluate the feasibility of this industry using technical cooperation schemes (Japan, USA, and Canada) as well as some private initiatives (USA, Japan). For instance, technology transfer on salmon aquaculture in Chile was made through at least four channels: Japan-Chile salmon project (Shiraishi Hatchery[10]); Domsea Farms (Union Carbide and later by Campbell soup, US capital), FundaciónChile and NichiroChile (Hosono *et al*, 2016). These initiatives used an *ocean ranching aquaculture* technique in which the firm artificially released salmon juveniles into rivers and waited until grown salmon returned after 1 to 4 years in the sea. This technique was not successful in Chile because very few salmon returned. Despite this failure, critical human resources were created during this period that later became pioneers in the industry. The trial and error process continued until *net-pen aquaculture* technique was identified and successfully introduced by FundaciónChile and Nichiro (a Japanese private firm).

Experimentation by Entrepreneurs and Legitimation: Challenges for 'Cost Discovery'

In 1974, Sociedad de Pesquerías Lago Llanquihue Ltda, a domestic company to export cultivated rainbow trout was established by a former public officer. There was no financial support for start-up businesses; however, the strong motivation of the entrepreneur convinced the regional government to finance the project via Chilean Economic Agency (CORFO). The firm suffered from local specific fish diseases and climate conditions that almost destroyed the entire stock, but finally made its first exports to France in 1978 and to other markets in 1980 (Mendez *et al*, 1989).

In 1976, Union Carbide also started salmon production in Chile using 'ocean-ranching' operations under the company, Domsea Farms[11]. Although it managed to produce salmon fry, the ocean-ranching operation was not successful and the owner decided to withdraw from the business. In 1979, Domsea Farms was purchased by FundaciónChile, a private non-profit organization, making investments in new businesses. FundaciónChile started to implement a different fish-rearing method called 'net-pen aquaculture.'

Coincidentally, in the same year, 1979, a Japanese company, Nichiro Chile, also started to invest in salmon and trout farming introducing net-pen aquaculture. Nichiro subcontracted the incubation and fry rearing of coho salmon to the domestic pioneer firm, Sociedad de Pesquerías Lago Llanquihue. The operation of Nichiro Chile demonstrated that net-pen aquaculture was successful for salmon rearing. This discovery, along with the high market price of salmon at that time, fueled early movers' enthusiasm to enter the industry, gradually consolidating the legitimation of this industry.

At the early stage, producers were limited in number and had good communications via different personal social networks.[12] This allowed knowledge and information on production methods to diffuse quickly among local producers.

Knowledge Development and Diffusion: Role of FDI and FundaciónChile

Knowledge development in the 'formative' phase was characterized by knowledge transfer and diffusion. There were different channels of knowledge acquisition: through bilateral cooperation and government support in the 1960s, which helped early pioneers with basic knowledge of salmon farming; and through foreign investment (Union Carbide and Nichiro) in the late 1970s that made an important contribution in local skill upgrading as well as selection of critical technology, net-pen aquaculture. The successful application of new technology encouraged more entrepreneurs to follow the pioneers.

FundaciónChile played a critical role in promoting diffusion of technical know-how in this industry from the 1970s to early 1980s. First, it supported entrepreneurial experimentation by purchasing the project from Campbell Soup. Second, it contributed to the successful diffusion of net-pen aquaculture technique together with Nichiro. Third, it contributed by searching for and adapting knowledge to the local context through production-related research and experimentation with new technologies, such as artificial reproduction, behavioral studies, and breeding. They also created and exploited new freshwater and seawater farm sites (Achurra, 1997; SalmonChile, 2004), and designed net-pen farms for different species of salmon (i.e., king, pink and coho salmon, and rainbow trout). Fourth, FundaciónChile provided technical assistance to firms through sales of technology.

Market Formation: Linking with Markets in Japan and USA

During the 'formative' phase, most salmon (60 per cent) was exported to Japan (Figure 3). The prices were kept high, reflecting the high demand (Figure 4). To ensure that Chilean salmon could enter the market, Japanese buyers technically supported Chilean producers in complying with standards for quality and sanitation (Hosono *et al*, 2016).

Mapping the Functional Pattern: The Growth Phase

Development of Positive Externalities: Emergence of Salmon Clusters

In the 1980s, Chilean exports of salmon continued to increase and by the early 1990s the country had become the second biggest exporter after Norway. Accompanying the growth of exports, the number of local salmon firms increased (Figure 2). At the same time, the price of salmon started to decline due to oversupply. This price pressure obliged the industry to change its production structure at the local level: firms started outsourcing their auxiliary activities (such as cage making, maintenance, feed making, diving, and transport), while specializing in the core activities of fish rearing. As a result, a cluster of salmon farms was created.

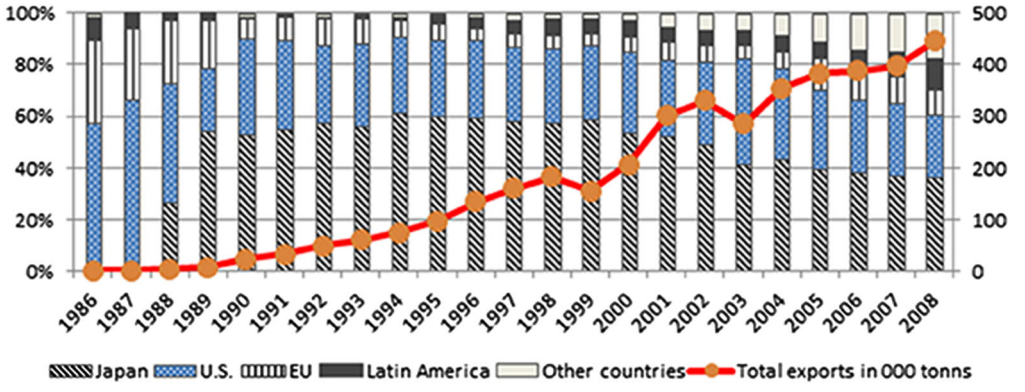

Figure 3: Share (%) of major destinations for Chilean salmon export, and exports by volume (thousand tons).
Source: Based on Achurra (1997) and SalmonChile (2009).

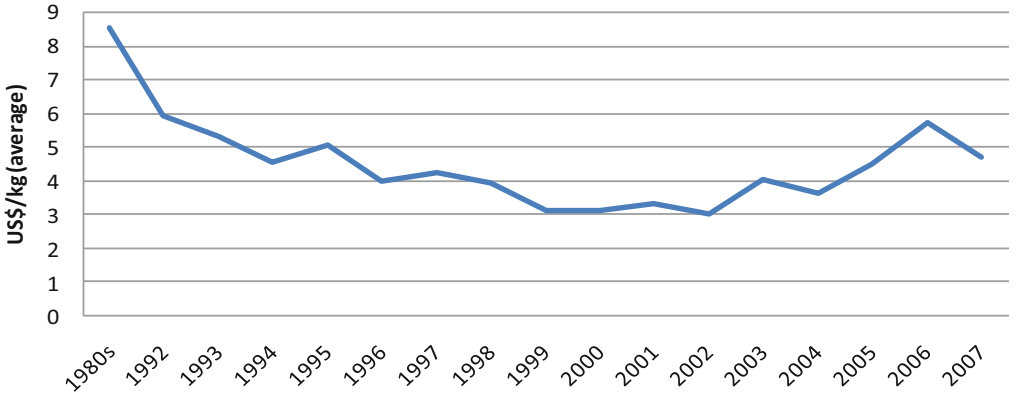

Figure 4: Changes in price of salmon per kg, 1980s–2007s.
Source: Based on *Revista Aqua* (various years).

Market Formulation and Development of Positive Externalities: Collective Efforts of Association

Sluggish demand in the Japanese and American markets created a difficult time for local producers in the early 1990s. To cope with this, firms started to collaborate to improve product quality and diversify market destinations. In 1986, the Association of Producers of Salmon and Trout in Chile (hereafter APSTC or the Association) was established (SalmonChile, 2003; Achurra, 1997; SalmonChile, 2004). The Association successfully established quality standards among domestic producers and explored new market destinations such as Europe, Latin America (Brazil, Argentina, and Mexico), and Asia (China, Thailand, and Taiwan). Despite these efforts, the shares of the top two countries, Japan and the USA, accounted for about 80 per cent of export volumes.

Guidance of Search, Resource Mobilization, and Legitimation: Strengthening Public–Private Dialog

Institutional development of the industry took place in the growth phase. Various financial mechanisms to support private sector development were established in 1990. Although not originally intended, a substantial amount of these funds were used for the development of aquaculture (Bravo *et al*, 2007). The availability of finance, emergence of the Association, and success of early pioneers in exporting salmon contributed to strengthening legitimation of the industry and encouraged more entrepreneurs to venture into this sector.

Several pieces of legislation on aquaculture were implemented in the 1990s.[13] For instance, in 1991, the government, through its General Law of Fishing and Aquaculture (LGPA), tried to organize the respective authorities to dictate regulations pertaining to the sustainable operation of aquaculture.

The impact on environmental sustainability became more visible in the 2000s, when the volume of Chilean salmon production reached 200,000 tons (e.g., Buschmann *et al*, 2009; Barton and Floysand, 2010); however, the government at that time was emphasizing exports and economic growth.[14] Despite the environmental and social concerns raised by local NGOs (e.g., FundacionTerram) and academics in the growth phase (1986–2000), scant attention was given to the issues by the authorities and firms.

Knowledge Creation and Diffusion: Learning by Doing and Interacting

Chilean firms acquired knowledge through interacting with foreign firms. In the growth phase, all foreign firms, except Nichiro Japan, operated at 'arm's length' via local partnerships to avoid risks specific to local climate and environmental conditions. This allowed domestic firms to receive technical assistance from their partner firms. Furthermore, domestic firms imported advanced machinery and made various incremental improvements in adapting production techniques such as harvesting methods, fish handling, and cold chain management.

FundaciónChile continued to play an important role in knowledge transfer and diffusion. It has organized multidisciplinary work teams in critical 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. Furthermore, its representatives were placed in Norway, Japan, Scotland, and the USA to channel vital information on market and production technology. Nevertheless, in the early 1990s, FundaciónChile ceased to perform the role of 'benevolent knowledge transferor and facilitator of knowledge diffusion' due to its internal change of policy (Hosono *et al*, 2016).

Parallel to that, APSTC, whose member firms accounted for about 80 % of total salmon exports, started to represent the whole industry in the National Commission for Aquaculture as well as in other public–private dialogs. The Association, therefore, not only provided knowledge for better market access and production but also created political power to negotiate with the government and other external entities.

Lessons and Concluding Remarks

Having presented two cases – floriculture in Ethiopia and salmon farming in Chile – and by adopting the 'functional innovation systems' framework in the developing country context, this section identifies general trends and generates some suggestions for policy elaboration in developing countries diversifying through promoting non-traditional export products.

First, the cases show that the natural comparative advantage is critical for 'cost discovery' in the early phase of export industry (Lin, 2011). However, this comparative advantage needs to be accompanied by favorable systemic conditions and appropriate interventions to sustain activities into the growth phase.

Second, it takes numerous interactions among markets, firms, and the public sector to identify the contours of a new industry. Both cases took at least 10 years for the first pioneers to appear from the initial ('unsuccessful') attempts made by the governments and another 15-20 years until the export industry takes-off.[15] This is because industry gradually takes shape through trial and error processes of (1) adapting technology to local conditions and building local specific knowledge (Katz, 2006), (2) building complementary activities/services (capabilities) for the new activity (Porter, 1990, Bergek *et al,* 2008b), and (3) 'cost discovery' (Rodrik, 2007) in dynamic global markets.

Third, while entrepreneurs play critical roles in 'discovering' the appropriate combination of factors of production, technological choice, and existing market niches through risk-taking by probing market opportunities (entrepreneurial experimentation), they cannot solve systemic problems such as infrastructure. Timely and appropriate policy interventions to tackle systemic bottlenecks are critical for the development of new activities.

Table 3: The seven functions of emerging export industries in developing countries: formative and growth phases

Functions	*Formative phase*	*Growth phase*
Knowledge development and diffusion	Accessing, transferring, diffusing, and mastering mature technologies from outside	Reverse learning, incremental improvement, learning through intense interactions with external (foreign) actors
Entrepreneurial experimentation	Discovering combination of available factors of production to produce already existing product at lower cost	Scaling-up activities through building stronger networks and strengthening complementary activities
Market formation	Basically linking to existing and established international markets	Complying with higher standards and market requirements; finding better market channels and access; sustaining position in market
Guiding the direction of search	Expectations and beliefs in growth potential of new activities caused by external events	Strengthening public–private coalition and aligning institutions for development of new activity
Legitimation	Market success and initiating public–private partnership	Similar to above
Resource mobilization	Mobilizing and building on deficient resources (i.e., human capital, finance, and complementary products/services) through interventions. This reinforces 'guiding the direction of search' and 'legitimation'	Influenced by 'guiding the direction of search' and 'legitimation' process
Development of positive externalities	Positive externalities arise from agglomeration and formation of advocacy coalitions	Increasing power of advocacy coalition in creation of positive externalities while agglomeration is consolidated into clusters with networks due to disintegration of production processes, thereby increasing complexities and dynamics

Source: Authors.

Fourth, firms' challenges change in a dynamic and evolutionary manner. Although firms overcame some critical challenges in the formative phase, they continue to encounter new forms of challenges in the growth phase. In fact, the components of each function change at each phase, reflecting evolving challenges as the industry grows (Table 3). For instance, the main component of 'entrepreneurial experimentation' shifted from 'cost discovery' to 'scaling up'; the components of 'market formation' shifted from 'linking to market' to 'sustaining competitiveness in market'; 'knowledge development and diffusion' shifted from 'imitating and adapting matured technology' to 'intensive learning via interaction with external actors.' In the growth phase, with clearer contours of the emerging industry, 'guiding the direction of search,' 'legitimation' started to converge and became more targeted to sector with stronger presence of public–private coalition and institutions to facilitate further deepening of respective industries. Similarly, 'development of positive externalities' is marked by increasing industrial complexity and dynamics and increasing power of advocacy coalitions.

The above changes in the components of functions imply the need for changing policy focuses in each phase. In the formative phase, since the shape of the industry is still unclear, a generic set of incentives can be provided in parallel with frequent interactions with the emerging private sector to 'discover' any 'below the radar' activities. Once the industry is more consolidated, targeted policy becomes pertinent via private–public partnership because, during the 'growth phase,' the challenges become more sector-specific and systemic—namely building physical, institutional, and intellectual (human resources and technical expertise) infrastructure—that cannot be tackled by individual 'pioneers.' Hence, policy interventions should not be limited to rewarding the 'pioneers,' but should also target follower entrepreneurs with increased systemic focus involving facilitation, intermediating, and monitoring. The involvement of intermediary institutions, like EHPEA in Ethiopia and Fundación Chile and APST in Chile, is critical in such processes. This is consistent with the view that strategic collaboration between the public and private sector is needed to identify the most significant obstacles to restructuring (Rodrik, 2004), thus enabling elaboration of an effective set of interventions. The adapted functions framework for the development of export sectors can be used in this context to facilitate the policy elaboration process in developing countries.

Notes

1. The Development Policy Review, 2009 edition (volume 27, issue 5), presents a debate between Justin Lin and Ha-Joon Chang on whether Industrial policy in developing countries should conform to comparative advantage or defy it.
2. See Appendix Table A1.
3. The survey was conducted jointly between the Ethiopian Development Research Institute (EDRI) and the Japanese National Graduate Institute for Policy Studies (GRIPS). (See Table 1 for some descriptive statistics).
4. The survey was conducted on 62 firms and interviews were conducted with 33 people working on various types of activities see Appendix Tables A2 and A3.
5. Examples include renewable energy, fuel cells, nanotechnology, and mobile data (Negro *et al*, 2007; Negro and Hekkert, 2008; Bergek *et al*, 2008a).
6. Note that 'firm' here refers to a business entity engaged in the production and export (directly or indirectly) of floriculture products.
7. There are some indications that exit from the flower business is higher among the domestically owned companies than foreign-owned ones. The increasing dominance of the foreign-owned companies might impact the long-term sustainability of the sector.

8. Calculation based on the trade statistics in Chile and World Bank database.
9. The sanitary crisis took place in the industry in late 2007. This paper only covers the initial phases for comparative reasons.
10. Very few reference were made to Shiraishi Hatchery in existing studies on the Chilean salmon industry; however, this hatchery, together with Domsea farms, contributed greatly to building of domestic technological capacities for hatchery and fry rearing.
11. Union Carbide started Domsea farms in 1976. This firm contributed by importing eggs and starting a hatchery and production of fry to initiating catch-and-release aquaculture. In 1979, the company was renamed Domsea Pesquera Chile Limitada and was sold to Campbell Soup Co. However, Campbell soup showed no interest in this business and sold this firm to FundaciónChile (Hosono *et al*, 2016). This firm later sold the company to Nissui and is now called Salmon Antarctica.
12. Hosono *et al* (2016) mentions that many producers were personal friends who had studied at the same university despite working at rival companies.
13. See Iizuka (2007) for further details on the legislation.
14. Although the government established Regulations on Environment and Sanitation for Aquaculture (RAMA & RESA), these were not implemented due lack of resources (Iizuka, 2007).
15. See Appendix Table A1.

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Appendix A

See Tables A1, A2, and A3.

Table A1: Comparison of the Ethiopian flower and Chilean salmon industries

	Ethiopian flower industry	*Chilean salmon industry*
Natural advantages	Flat land at high altitude, cool climate, low-cost labor, short distance to European market	Clean water, longer luminosity, quiet environment, suitable water temperature, low-cost labor, access to fishmeal, key input
Year started	1980s	1960s
Year pioneer appeared & name of pioneer	1993, Meskel Flowers	1974, Sociedad de Pesquerias Lago Llanquihue Ltda
Year of FD & name of FDI	1999, Golden Rose Agrofarms (UK-based)	1976, Union Carbide, USA; 1979, Nichiro, Japan
Year of take-off	2004	Mid-1980s
Year established association & name	2002; Ethiopia Horticulture Producers and Exporters Association (EHPEA)	1986; Association of Producers of Salmon and Trout in Chile (APSTC), in 2002 change to SalmonChile
Critical technology choice	Highland, rose, modern steel-structured greenhouse	Net-pen technique
Main market	Europe (UK, Germany, Netherlands)	Japan and the USA
Main products	Rose, high-quality hybrid T	Salmon salar, salmon coho, trout
Market leader	The Netherlands	Norway
Rank in export market	7th in the world and 2nd in African continent since 2010	2nd in the export of farmed salmon since 2000
Dominant economic policy at take-off	Transformation from command to market economy	Transformation into market economy
Formative phase	1993–2003	1974–1985
Growth phase	Since 2004	1986–2000
Export value at take-off	USD6.5 million (2004)	USD1 million (1985–1986)
Recent export value	USD170 million (2010)	USD2490 million (2008)

Source: Authors.

Table A2: Descriptive statistics of survey (2004) samples: Chile

No. of firms	*Association member*		*Exporter*	
	Member	*Non-member*	*Exporter*	*Non-exporter*
Located in X region of which with address	25	70	49	46
	24	63	43	44
Acutal sample taken	19	22	29	12

Note: * Exports more than 80 % of production.
Source: Based on Iizuka (2007).

Table A3: Descriptive statistics of interviews for Chilean salmon case (2004, 2009, 2011)

	2004	*2009*	*2011*
Government	20	8	5
NGOs & Unions	4	2	3
Sector-specific organizations*	4	3	2
Academics abd experts**	5	3	2
Total	33	16	12

Notes: * includes association, former employees, consultants, sector-specific magazine editor. ** includes University professor, veterinarians, and experts.
Source: Authors.