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INNOVATION CAPACITY EVALUATION FRAMEWORK FOR SUSTAINABLE VALUE CHAINS

Um framework para avaliação de cadeias de valor sustentáveis

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Abstract: Innovation is highly demanded for achieving competitiveness and sustainability in value chains. However, few empirical studies have been conducted to identify causal conditions and measurements of innovation capacity in value chains, particularly in developing countries. Combing concepts and methods from value chain upgrading, technological capability and sustainability-oriented innovation system literature, this study aims at identifying a condition or combination of conditions for promoting innovation capacity for inclusive sustainable value chains. It then empirically analyzes the necessary conditions and identifies multiple paths for developing innovation capacity by taking up the cases of two local and two globally linked value chains from Ethiopia. The study also develops a comprehensive innovation capacity evaluation model by combining different capability building strategies and learning mechanisms, and applies a comprehensive fuzzy evaluation method for measuring the level of innovation capacity of the four value chains. The study identifies eight main dimensions of innovation capacity for sustainable value chains, which are categorized into four groups in order to identify necessary and sufficient conditions. The study finds that the simultaneous presence of technological upgrading, value chain restructuring and green governance reforms is sufficient conditions for the development of innovation capacity. We also find that public-private partnership (innovation platform) is necessary condition for achieving outstanding value chain innovation capacity. By developing and applying a fuzzy comprehensive evaluation model for measuring value chain innovation capacity and fuzzy set qualitative comparative analysis for identifying necessary and sufficient conditions for innovation capacity development in a sustainable value chain, the study makes an important methodological contribution to existing literature. It also provides relevant insight for policy makers and practitioners in designing strategies and policy instruments for achieving a high degree of innovation capacity.
Keywords: Innovation capacity, sustainable value chain, fuzzy qualitative comparative analysis

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Resumo: A inovação é muito exigida para alcançar a competitividade e a sustentabilidade nas cadeias de valor. No entanto, poucos estudos empíricos foram realziados para identificar condições causais e medidas da capacidade de inovação nas cadeias de valor, particularmente nos países em desenvolvimento. Combinando conceitos e métodos de melhoramento de cadeias de valor, capacidade tecnológica na literatura de sistemas de inovação orientados para a sustentabilidade, este estudo tem como objetivo identificar uma condição ou combinação de condições que permitam promover a capacidade de inovação para cadeias de valor sustentável inclusivas. Em seguida, analisa empiricamente as condições necessárias e identifica múltiplos caminhos para o desenvolvimento da capacidade de inovação, abordando os casos de duas cadeias de valor locais e duas vinculadas ao nível mundial na Etiópia. O estudo também desenvolve um modelo abrangente de avaliação da capacidade de inovação, combinando diferentes estratégias de construção de capacidades e mecanismos de aprendizagem, e aplica um método abrangente de avaliação fuzzy para medir o nível de capacidade de inovação das quatro cadeias de valor. O estudo identifica oito dimensões principais da capacidade de inovação para cadeias de valor sustentáveis, que são categorizadas em quatro grupos para identificar condições necessárias e suficientes. O estudo conclui que a presença simultânea de atualizações tecnológicas, reestruturação da cadeia de valor e reformas da governança verde são condições suficientes para o desenvolvimento da capacidade de inovação. Também fica em evidência que a parceria público-privada (plataforma de inovação) é uma condição necessária para alcançar uma excelente capacidade de inovação na cadeia de valor. Ao desenvolver e aplicar um modelo de avaliação abrangente fuzzy para medir a capacidade de inovação da cadeia de valor e a análise comparativa qualitativa dos conjuntos fuzzy para identificar as condições necessárias e suficientes para o desenvolvimento da capacidade de inovação em uma cadeia de valor sustentável, o estudo contribui metodologicamente para a literatura existente. Ele também fornece uma visão relevante para os formuladores de políticas e os profissionais na concepção de estratégias e instrumentos políticos para alcançar um alto grau de capacidade de inovação.
Palavras chave: Capacidade de inovação, cadeia de valor sustentável, análise comparativa qualitativa fuzzy

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INTRODUCTION

Forests are the foundation of sustainable development. Recognizing their critical roles in providing multiple functions for achieving local and global sustainable development, the United Nations' Sustainable Development Goals (SDG) have given due attention to protection, restoration and sustainable use of forests and ecosystems and included them as one of its key targets. Forests cover 31 percent of the world's land area and provide a very wide range of products and ecosystem services delivering social, environmental and economic benefits (Brack, 2014). Forests are the basis of livelihoods for more than 1.6 billion people and the means of survival for 200 million people, including many indigenous people (Brack, 2014). As in many tropical countries, forests are of high economic, ecological and social importance for local people in Ethiopia.

However, numerous drivers of change are creating a range of fundamental economic, ecological and social challenges such as chronic poverty, environmental degradation and weak competitiveness of value chains for local residents. Like other developing countries, Ethiopia had followed the command and control approach by designating the most important forest areas as58 National Forest Priority Areas (NFPA), with a total area of 4.8 million hectares in the late 1980s.Despite the explosion of such regulatory and protectionist approaches, catastrophic deforestation has been a key driver of changes in the forest ecosystem in Ethiopia. The forest cover of Ethiopia has dwindled at an alarming rate and reached less than 3% as of 2001, as compared to its original coverage of 35-40% four decades earlier (Bishaw, 2001, August). Such severe deterioration of forest resources has not only threatened the ecological and biodiversity conservation functions of forests but also severely affected the livelihoods of local communities. In addition, several challenges and constraints have confronted the non-timber forest product (NTFP) producers in realizing the potential of NTFP commercialization in Ethiopia. These challenges include, among others, low competitiveness of actors along the entire market chain, poor use of modern technology and knowledge, poor capacity of actors and a weak and fragmented marketing system (Bognetteau, Haile, & Wiersum, 2007, March; Deffar, 1998; Woldu, 2004, November).

In order to achieve sustainable development, innovations, both in terms of resource management, product processing and marketing, have been proposed(Marshall, Schreckenberg, te Velde, & Newton, 2006).More recently, value chain innovation (VCI) as one of the new models of inclusive innovation, has been accentuated in overcoming risks, vulnerability and key constraints and as source of competitive advantage (MarshalL & Schreckenberg, 2005; Martin, 2012). Value chain innovation is defined as "a change (incremental or radical) within the supply chain network, supply chain technology, or supply chain processes (or combinations of these) that can take place in a company function, within a company, in an industry or in a supply chain in order to enhance new value creation for the stakeholder"(Arlbjørn, de Haas, & Munksgaard, 2011). It comprises wide ranges of innovations occurring in the functions of a firm and within chains to changes in supply chain as a whole.

The introduction of innovation requires development of innovation capacity, which can be defined as "the context specific range of skills, actors, practices, routines, institutions and policies needed to put knowledge into productive use in response to an evolving set of challenges, opportunities and technical and institutional contexts" (Hall, 2005). Previous studies found a strong relationship between types of innovation introduced in a value chain and that chain innovation capacity (Arlbjørn et al., 2011; Ferrer, Hyland, & Bretherton, 2009).Value chain innovation capacity is defined as "a continuous improvement of the overall capability of firms to generate innovation for developing new products and processes to meet market needs (Ferrer et al., 2009, p. 198). It is also understood as "the intra and inter-organizational competence within supply chain to cooperate, to identify, develop and implement original, solution-oriented actions that address new or previously unsolved problems" (Storer & Hyland, 2009, p. 916). Although VCI literature has identified types of innovation in supply chains (Arlbjørn et al., 2011; Kaplinsky & Morris, 2000), it lacks a proper examination of causal conditions or mechanisms required for the introduction of value chain innovation (Arlbjørn et al., 2011; Morrison, Pietrobelli, & Rabellotti, 2006). In addition, studies on the evaluation of innovation capability for the natural resource sector in least developed countries are scant (Bell & Figueiredo, 2012). It is thus important to know what combinations of conditions enable producers and community firms in developing countries to build innovation capacity and successfully introduce innovation in their activities that helps to integrate them into the global market. Academic studies are unclear about what combination of conditions helps successfully achieve a higher level of innovation capacity for a sustainable value chain in the natural resource sector. In addition, the conventional input/output based metrics used for assessing innovation capability, such as patents and investment in research and development, are incapable of understanding how the innovation process occurs and inappropriate to apply in developing countries (Gregersen & Johnson, 2005; Zawislak & Marins, 2007).Since innovation capacity in a value chain is viewed as having multidimensional capabilities (Ferrer et al., 2009; van Kleef & Roome, 2007), developing a holistic framework that combines different approaches in building the innovation capacity of a typical value chain has extreme relevance.

In order to solve deforestation risks and challenges in the forest value chain, governance reform and strategic CSR initiatives have been introduced by a public-private partnership (PPP) of government and international development organizations in southwest Ethiopia since 2000. First, the current government of Ethiopia has adopted market-oriented development models and made multiple reforms and changes in macroeconomic policies. The government has adopted a federal system of governance, giving the regional states and local communities much more power to control their natural resources and implement their development activities.

Commendable efforts have been made to change step by step the institutional conditions and the sectoral policies and strategies through multiple reforms and programs, including the decentralization of forest and natural resource management, liberalization, provision of environmental policy, forest policy and regulation, conservation strategies and establishment of environmental agencies at the federal, regional and local levels. Second, the FARM AFRICA/ SOS Sahel project was focused on providing forest user rights to communities and introducing joint or participatory forest management to improve the efficiency and effectiveness of forest utilization and conservation. Along with these efforts a number of policy reforms, including decentralization of forest management and community-based natural resource management, have been carried out with the aim of increasing local participation and benefit to the local community in natural resource control, management and use. The integrated approaches have aimed to both improve the livelihood of the community and promote the conservation of biodiversity in the region using a mix of economic incentives and institutional arrangement measures along with the government forest regulation in southwest coffee forests. Third, the strengthening of the community cooperatives project by the United States Agency for International Development (USAID) and its implementation by Agricultural Cooperative and Development International (ACDI)and the Honey Value Chain Development Programme by The Netherlands Development Organization(SNV) through support to the Business Organizations and Access to Market Programme (BOAM) has mainly focused on improving the business and institutional conditions for developing the value chain and marketing of forest honey and bee products. Fourth, the NTFP Southwest program has engaged both in the provision of forest user rights and the improvement of business and institutional conditions for NTFP development and commercialization, along with a participatory forest management approach designed to contribute to sustainable forest management and poverty alleviation. Fifth, the PPP project by GTZ and the conservation and use of the wild population of coffee Arabica in the montane rainforests of Ethiopia (the COCE project), on the other hand, focused on forest coffee value chain development and the conservation of the genetic diversity of wild Arabica coffee and promotion of NTFP certification to increase public understanding and awareness of the real value of biodiversity and conservation of the natural environment of Arabica coffee. These projects aimed at not only the establishment of the Kafa biosphere reserve by the United Nations Educational, Scientific and Cultural Organization (UNESCO) but also enhancing the adaptive capacity of local communities for sustainable forest resource use and management and developing value chain integration and the introduction of new technology. They also aimed at linking remote forest-dependent people to regional, national and global market chains through new market arrangements.

The research question, then, is what condition or combination of conditions leads to the development of innovation capacity in the non-timber forest product value chain and can successfully introduce innovation for an inclusive and sustainable NTFP value chain and for sustainable forest resource management? The objective of this study is to identify the combination of conditions for building value chain innovation capacity and to develop a comprehensive evaluation model for measuring the level of innovation capacity.

This study explores causal conditions for the development of value chain innovation capacity by taking four cases focusing on two non-timber forest product value chains, honey and coffee from Ethiopia. The qualitative comparative analysis presented in the research allows us to identify the conditions through which these four different chains build their capabilities and add value within the different nodes of the chain. By identifying different causal conditions for building innovation capacity within the context of LDCs through applying fuzzy set qualitative comparative analysis, and by developing and applying a fuzzy comprehensive evaluation method for measuring innovation capacity, this study made a methodological contribution to the existing literature on innovation capacity for sustainable value chains in the natural resource sector in least developed countries.

The rest of the paper is structured as follows. Section two develops the analytical framework by reviewing empirical and theoretical literature. Research methodology of the study is discussed in third section. Section four presents the empirical results and analysis of the study. The final section discusses the main findings and its implications.

ANALYTICAL FRAMEWORK

Drawn on different perspectives, existing literature provides ample candidates for causal conditions for innovation capacity outcome in value chains. Since capabilities are rooted in the specific kind of purposeful learning processes, activities and efforts undertaken (Bell & Figueiredo, 2012; Ernst, Ganiatsos, & Mytelka, 1998), capability literature on latecomer firms deals mainly with identifying processes or conditions for building a knowledge base, learning and knowledge transfer mechanisms in latecomer firms located in developing countries (Vallejo, 2010).Technological capability literature identified two learning mechanisms–internal and external ones(Bell & Figueiredo, 2012).In addition, three main strategies used for competence building include internal competence building; hiring and firing; and networking and alliance (Lam & Lundvall, 2007).

According to Chiesa, Coughlan and Voss (1996), innovation processes can be grouped into core processes and enabling processes. Core processes are innovation practices that are essential to converting the product or process concepts into deliveries to external customers, while enabling processes are innovation practices that support the core processes with the conversion of resources and strategic visions for guidance and a foundation for innovative activity. In this study we analyze and measure innovation capacity using a process-based approach and its dimensions like breadth, depth and integration. The breadth is the coverage of technological effort among relevant dimensions. The depth of technological effort refers to the level of investment made or the stage of development of activities performed in a respective dimension, while integration of technological effort is the degree of relevance and linkage of technological effort to the development of innovation capacity. We briefly discuss different causal conditions of value chain innovation capacity as follows.

CAUSAL CONDITIONS

1.Skill and competence building: This strategy focuses on skill development and human capital formation and relates to internal and external learning mechanisms identified in technological capability literature (Bell & Figueiredo, 2012; Romijn & Albaladejo, 2002).

2.Local institutional reform and policy support: This dimension includes government policy and support in terms of existence of innovation strategy; macroeconomic stability; financial resource access and the incentive system (Dahlman, Ross-Larson, & Westphal, 1987; Ernst et al., 1998; Lall, 1992); development and functioning of the components of an innovation system such as an efficient supporting organization, provision of global knowledge, appropriate incentives, regulations, implementation of proactive programs for product development, provision of information on new activities, basic market institutions and promotion of socially inclusive technological learning (Aubert, 2004; Chaminade, Lundvall, Vang-Lauridsen, & Joseph, 2009; Tilman, 2008, September); establishment of supporting institutions (Gregersen, Johnson, & Segura, 2004); development of human and social capital for clusters (Chaminade & Vang, 2008); creation of institutional conditions for friendly business regulation, emergence of intermediaries, and flexible organizational structures; knowledge management practices and technical and managerial competence development (Chaminade et al., 2009).

3.Innovation platform learning: Innovation platform is an implementation tool for chain empowerment. An innovation platform refers to a forum established to foster interaction among diverse stakeholders around a shared interest and facilitates the development, dissemination and adoption of knowledge in the form of new ideas, methodologies, procedures, concepts or technologies used or adapted from other locations for socio-economic benefit (Makini, Kamau, Makelo, & Mburathi, 2013). According to Coraf/Wecard (2012), innovation introduced by a platform may include technological, institutional, organizational, market and policy information. Innovation brokers play a key role in connecting innovation platforms at different levels (local, intermediary, national) and facilitate learning processes through the flow of information among partners, making social and institutional arrangements, building and managing innovation networks, integrating global and local knowledge and supporting others for social learning processes. Different processes for innovation platforms identified by CORAF/WECARD (2012) and Makini et al. (2013) include capturing current knowledge, attitudes and practices; engagement with stakeholders; co-development of action plan and strategy; implementation and participatory learning; financing and project portfolio management; and upgrading the enabling environment.

4.Technological upgrading: Technological upgrading is the expansion of technological skills and capacities of a firm and includes both process upgrading and product upgrading(Brach & Kappel, 2009).

5.Value chain restructuring: Value chain restructuring mainly focuses on the structure of the value chain. Ferrer, Hyland and Betherton explored the role of relational capabilities for supply chain innovation and found that entering a competence building relationship with customer and supplier firms can build dynamic capability that enhances capacity for supply chain innovation (Ferrer et al., 2009). According to KIT, Faida, and IIRR (2006), value chain empowerment requires the undertaking of horizontal coordination and vertical integration. The processes for horizontal coordination include information management, quality management and control, innovation management and chain cooperation. Vertical coordination requires the introduction and use of appropriate and modern technology, access to finance and skills (building of managerial and technical competence and organization skills), adding activities adhering to quality standards and delivery processes such as investing in facilities for processing, marketing and distribution (infrastructure and professional staff), developing market outlets, designing and implementing management systems (operational procedures) and developing organizational discipline (KIT et al., 2006).

6.Market orientation: Market orientation is an integrative processes designed to apply the collective knowledge, skills and resources of the actors within the value chain in generating and disseminating intelligence pertaining to current and future market needs along the value chain, enabling the business to value its goods and services and meet competitive demands. Studies have indicated that market capability development is positively related with the innovation intensity and competitive advantage of the firm (Eng & Okten, 2011; Tukamuhabwa, Eyaa, & Derek, 2011; Weerawardena, 2003). Hou (2008) viewed market orientation as a set of dynamic capabilities and showed how market orientation can be transformed into dynamic capability to affect firm performance. Core elements of market orientation include customer service, promotion activities/communication, quality of sale persons/selling, distribution networks and management, resources committed for advertising, market research efforts, product differentiation, new product development and efforts to reach target markets (Vorhies & Morgan, 2005; Weerawardena, 2003).

7.Global institutional arrangements: Many scholars have stressed that institutions can play critical roles in development and sustainability (Gregersen et al., 2004; Rennings, 2000). Institutions may extend from local networks to public participation in improved decision-making to new regimes of global governance. A study by Perez-Aleman (2011) indicated that adoption of global food safety and environmental standards significantly contributes to local innovation capacity building through knowledge flows and access to external knowledge, interaction of local indigenous knowledge with global practices, creation of new local institutions for coordination and organizational improvement, collaboration of many actors, provision of training and capacity building for smallholders. However, the success of this strategy for developing the innovation capacity of smallholder firms depends on local efforts to undertake active institutional reforms at various levels and to support capacity building (Perez-Aleman, 2011). In addition, Bello(2004) indicated that the market orientation activities need to include global institutional arrangements for successful introduction of global value chain innovation since the international institutional framework and environment have strong effects on the investment decisions of lead actors.

8.Green governance reforms: The environmental upgrading literature emphasizes the need for improvement in environmental performance beyond value chain upgrading (Jeppesen & Hansen, 2004). Accessing eco-innovation can help in solving environmental problems and gaining access to new technology for product and value chain upgrading in developing countries (Ockwell et al., 2010). Eco-innovation can be defined as all measures of relevant actors who develop and apply new ideas, behavior, products and processes to reduce environmental burdens or to achieve ecologically specified sustainability targets (Rennings, 2000).Diverse processes and measures for building greening capability include pursuing self-regulation or eco-entrepreneurship strategies coupled with the use of traditional environmental policy instruments(Andersen, 2004), use of incentive instruments(market creation, fiscal incentives) and undertaking basic R&D (Stamm, Dantas, Fischer, Ganguly, & Rennkamp, 2009). In addition, availability of environmental regulation, government support and forest sector policy (Bernauer, Engel, Kammerer, & Nogareda, 2006; Rennings, 2000); collaboration and interaction among institutions/actors;availability andacquisition of new technical knowledge; andpublic investment as well as market demand foster innovation processes in forestry (Kubeczko, Rametsteiner, & Weiss, 2006; Rametsteiner & Weiss, 2006; Schaan & Anderson, 2002). Technical collaboration with foreign firms; monitoring and controlling; cross-functional collaboration and knowledge sharing; investment in new and clean technology; green skill development and training; development of a written environmental plan; development of environmental performance criteria; internal assessment of implementation of an environmental plan; implementation of certification and ISO 14001 standards; and extension of environmental criteria to the entire value chain are important processes for the adoption of greening practices (Darnall, Jolley, & Handfield, 2008; Jeppesen & Hansen, 2004). Existence of stakeholder dialogue and stakeholder knowledge integration, cultural and institutional development, public education, participatory environmental assessment and self-organization are key processes for changes in governing structures, efficient resource management, product stewardship and habitat preservation as well as for reducing pressure on natural resources (Berkes & Turner, 2006; Hart, 1995; Tabara & Pahl-Wastl, 2007).

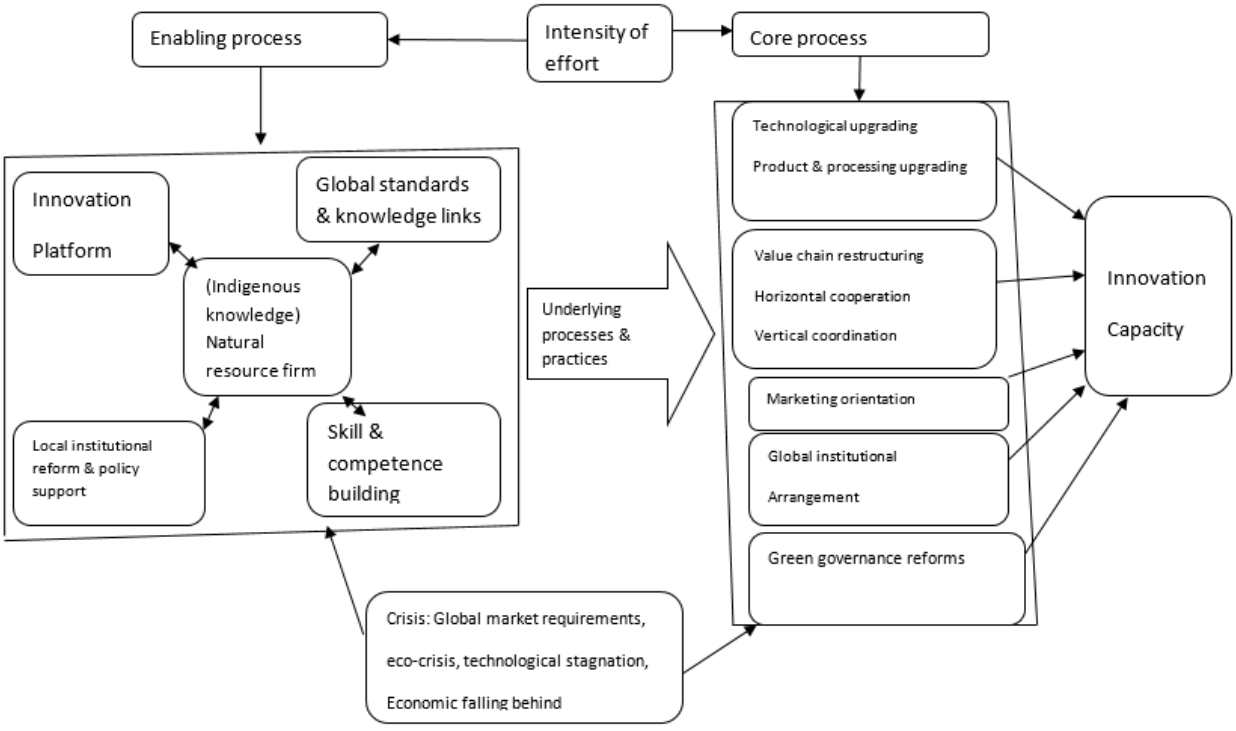

Figure 1: Dimensions of Innovation Capacity in Value Chain

METHODOLOGY

Developing a Comprehensive Evaluation System

In order to assess different causal conditions for innovation capacity of value chains we developed an innovation process assessment model. It focuses on the evaluation of processes required for introducing value chain innovation and the extent to which best practices are in place. The model offers the essential elements of effective processes for one or more dimensions of innovation capacity and describes an evolutionary improvement path from simple or unperformed to mature and satisfactorily performed processes. It allows an evaluator to assess processes, activities and efforts for components of innovation capacity individually and helps to identify and focus on weakness and success areas and measuring improvement or progress on a finer-grained scale. Drawing from our review of literature we have identified eight main conditions for developing innovation capacity in value chains. Table 1 and Table 2 present enabling and core conditions and their process/practices, respectively.

Table 1
Technological effort and practices for enabling processes

Dimension (Author, year)	Technological practices
Innovation platform learning (CORAF/WECARD, 2012; Gregersen & Johnson, 2005; Makini et al., 2013; Perdomo, Klerkx, & Leeuwis, 2010; Zawislak & Marins, 2007)	Engagement with stakeholders; assessment of the needs, challenges and opportunities; co-development of an action plan and strategy; joint project implementation; financing innovation& project management; knowledge development & dissemination (research, workshop, meeting, etc.); upgrading of enabling environment
Skill& competence building (*B*ell & Figueiredo, 2012; Romijn & Albaladejo, 2002)	Hiring skilled people, formal and informal training, formal and informal R&D, investments in technological licenses, observation of routine production activities, acquisition of knowledge from undertaking repair and maintenance, various kinds of intra-firm communication of knowledge, knowledge articulation and assimilation, various forms of experience, organizational arrangements for knowledge creation and codification
Local institutional reforms and policy support (Aubert, 2004; Chaminade et al., 2009; Gregersen et al., 2004; Larsen, Kim, & Theusn, 2009; Narayan, 2002; Tilman, 2008, September)	Macroeconomic stability, characteristics of biodiversity resources and market conditions, innovation supportive services delivery, regulation & legal framework, institutions, network and cluster interaction

Source: Compiled by author based on references

Table 2
Technological effort and practices for core processes

Dimension (Author, year)	Technological effort/innovation practices
Value chain restructuring (Kaplinsky & Morris, 2000; KIT et al., 2006; Perdomo et al., 2010; Roduner, 2007)	Horizontal linkage formation: Innovation management, establishing collective structure, quality management and control system, chain cooperation, information management, quality of management and entry rules
	Vertical linkage formation: Business network and structure (joint venture cooperation, supplier-buyer partnership, process integration (information system, logistics, operational alignment), acquisition of new functions/chain activities, provision of embedded services, trust, commitment & communication, increase in value chain efficiency
Technological upgrading (Kaplinsky & Morris, 2000; KIT et al., 2006)	Product upgrading: Introduction of new production system, improvement in product quality, (implementation of traceability and hygiene standards), investment in facilities and assets
	Processing upgrading: Introduction and use of appropriate and up-to-date technology, technical support and capital equipment supply, improved local processing (grading, processing, transport), building of managerial and technical competence adhering to quality standards, delivery processes (total quality management), organization skills for joint value-adding activities

Market orientation (Eng & Okten, 2011; Tukamuhabwa et al., 2011; Vorhies & Morgan, 2005; Weerawardena, 2003),	Market intelligence, marketing networks/infrastructure, customer service distribution networks & management, quality of sale persons/selling, market research efforts, product differentiation (new packaging, labeling, brand), efforts to reach target markets, promotional campaign
Global institutional arrangements (Bello et al., 2004)	Setup of local requisite institutions, use of and engagement with multicultural expert groups, setup of monitoring and standard institutions, openness, investment climate & export promotion, number of accredited companies
Dimension **(Author, year)**	**Technological effort/innovation practices**
Green governance reforms (Darnall et al., 2008; Gregersen et al., 2004; Hart, *1995;* Jeppesen & Hansen, 2004; Rennings, 2000; Sharma & Vredenburg, 1998),	Environmental management tools (creation of governing structure, resource management, adaptive co-management); certification & eco-label; environmental knowledge & information provision (stakeholder dialogue and knowledge integration); environmental monitoring, audit and compliance; reduction in pressure on natural resources and use of energy; incentive system (property rights, market creation, technological support, financial support); habitat preservation (biosphere); environmental regulation

Source: Compiled by author based on references

With regard to the depth of technological capability, Bell and Figueiredo (2012) found that taxonomy of the levels of capability is based on the types of innovative activity undertaken in a specific category rather than on the quantities and qualities of resources required (human resources, skills, knowledge base). Following Bell and Pavitt (1995), this study categorizes the depth of innovation capacity into low, moderate, good and advanced levels depending on the progress of the underlying processes, activities, knowledge base and innovation efforts made (see Table 3).

Table 3
Depth of Innovation Capacity

Level of Innovation Capacity	Performance of Innovation Practices (%)	Innovation Targets
Low	< 45	Operational routine
Moderate	45-64	Duplicative imitation/incremental
Good	65-84	Creative imitation/adaptation
Advanced	>84	Breakthrough

The Data

This study is conducted in the Kafa and Bench Maji zones of southwest Ethiopia where half of the country's remnant natural forest ecosystem with its rich biodiversity exists and where forest coffee and forest bee products are dominantly produced for export markets. The selection of cases for our study was made after detailed discussion and exchange of information with experts, key informant interviews and secondary sources. We used a purposeful sampling method for selecting cases. Three important criteria were used for selecting cases. First, the NTFP value chain is restricted to those products that are extracted from the natural forest ecosystem. The NTFP selected for this study are forest coffee and forest honey and beeswax from southwest forests. Second, the value chain has to include and link the marginalized and rural indigenous NTFP producers and collectors to national or global markets. Third, there must be differences between the value chains in the type of intervention and implementation of innovation activities and differences in the nature of their business relationship/model. Based on these criteria, we selected two domestic value chains–the Kafa forest honey union chain and the Bench Maji forest coffee union chain – and two globally linked NTFP value chains–the NTFP Cooperative Apinec PLC Chain and the Kafa forest coffee union value chain.

We have collected data and information from primary sources. Three round trips for field work were made to collect data from the study areas. Key informant interviews were conducted using semi-structured guidelines with board executives and staff of cooperatives, union managers, private processing firms, model farmers, government and non-governmental organizations. The interview guideline included several relevant issues starting with discussion of the company's background, and then it focused on innovation introduced and innovation activities, objectives/drivers of innovation and sources of knowledge, ideas and information. It also included sections on partners and their roles and the support from the innovation system in innovation processes. The characteristics of innovation projects such as their motives, approaches, project partners and their network and collaboration, project governance, project resources, activities and benefits and barriers in innovation processes were included in the interview guidelines.

Table 4
Sources of primary data

Company/Union	Position of Interviewee	Focus Group Cooperatives
Kafa forestcoffee union	Union manager, processing/quality officer, executives of management board	Minchit, Diri, Keyakello, Chiri
Bench Maji Forest coffee union	Union manager, processing/quality officer, marketing officer	Mehal Sheko, Gize Meret
NTFP Cooperative Apinec PLC Chain	Vice manager, processing technology and production officer	Yeyibto, Keja, out-grower farmer
Kafa Forest honey union	Union manager, processing and quality officer, executives of management board	Wish-wish, Matap

The members of the focus group discussion were three executives of cooperatives, three model farmers, one expert of a cooperative (development agent), one expert of an extension (development agent), and two subject matter experts from the zone and district (Agricultural and Rural Development Department, ARD). Interviews were also conducted with experts from the cooperative promotion office of each zone. In addition, the innovation capacity evaluation team with 24members including subject matter specialists, innovative farmers, cooperative/ union decision makers, general managers and staff of the union were asked to evaluate the innovation practices in their respective NTFP value chain. We also used secondary data sources. Review of project documents for all intervention projects including proposals, plans, progress reports, development strategies and policies and research reports were used for data compilation. Secondary data and information was also collected from records and archives of case companies. Detailed data and information regarding the implementation of innovation projects in four value chains was collected and used for case studies.

The Method

Three methods were used to conduct this research. First, multiple case studies that focus on two domestic and two global linked value chains were used to identify whether there are differences among cases. Second, we applied a fuzzy comprehensive evaluation method to measure the level of innovation capacity, which depends on how broad, deep and integrated the eight technological efforts or practices are for developing innovation capacity.

The general formula for computing innovation capacity is given by:IC= $\sum_{B=1}^{k} D_s * I_s$where IC= innovation capacity,Ds= depth of technological effort, Is=integration of technological effort and B = breadth of technological effort. The innovation capacity scorecard was designed and given to the evaluation team to rate the progress or performance of each practice and the importance or weight attached to each innovation practice using a 5-point Likert scale. Following Wanga (2008) and Lin, Lin, and Chiang (2011), we applied a fuzzy comprehensive evaluation method for measuring the level of innovation capacity. There are four key steps for a fuzzy comprehensive assessment method. For brevity we mention here only some steps. The steps include setting the evaluation index system(eight technological practices mentioned above); determining linguistic terms and a remark/assessment scale; determining the weighting set and evaluation matrix of a single practice and aggregating overall innovation capacity level (details of the mathematical matrix can be obtained from the authors upon request).

Third, innovation and sustainability outcome are influenced by a complexity condition. In this respect, qualitative comparative analysis (QCA)[1] is an appropriate methodological approach, because it addresses causal complexity by searching for conditions or combinations of conditions necessary or sufficient for an outcome of interest.QCA is a case-based method that helps to identify and understand different combinations of factors that are necessary or sufficient for a successful outcome in a given context (Befani, 2016). Thus it has certain unique strengths, including qualitatively assessing impact and identifying multiple pathways to achieving the change. It helps to generate robust findings about what makes the difference for success in different contexts and generalize those findings. The QCA method requires the availability of appropriate theories of change; identifying at least three to five cases; and collecting data across all cases for all conditions. The main principle of QCA is the examination of set theoretic relationships between causally relevant conditions and a clearly specified outcome in terms of necessity and/or sufficiency. It requires the analysis of necessary and sufficient conditions to produce the same outcome (Elliott, 2013). Necessary conditions are conditions that are required to produce the outcome. All cases that exhibit the outcome also exhibit a necessary condition, though necessary conditions may not be enough by themselves. Sufficient conditions are conditions that always lead to the outcome, so cases that exhibit the sufficient condition will also exhibit the outcome. Equi-finality means that there are multiple paths or solutions to the same outcome.

In fuzzy set Qualitative Comparative Analysis (fsQCA), consistency and coverage are parameters of model fitting. Consistency represents the extent to which a causal combination leads to an outcome. It ranges from 0 to 1.Coverage represents how many cases with the outcome are represented by a particular causal condition. Since we are assuming that the causal conditions lead to the outcome, it only makes sense to calculate coverage for rows that have high consistency. Rows with low consistency violate our assumption that the causal condition leads to the outcome. Unlike regression, which gives us the magnitude and direction of effect of a variable, net of other variables included in the model, the fsQCA model focuses on what conditions lead to a given outcome?

[1]Details of the QCA method can be found in Befani (2016).

There are different variants of QCA. The original crisp set variant uses either present or absent for each condition that is represented by a value of 1 or 0, respectively. In this study we applied fuzzy set QCA, which allows conditions to be somewhere on a scale between fully absent and fully present (represented by values between 0 and 1). We used fuzzy command in fsQCA in Stata 14 for our analysis.

Due to the interpretational and representation problems in the inclusion of a large number of conditions in a QCA analysis, we decided to aggregate related issues in our eight technological practices or processes into four conditions. First, we aggregated market orientation and global institutional arrangements with value chain restructuring condition. Second, local institutional reform, policy support and training and skill development are aggregated with technological upgrading. The remaining green governance reform and innovation platform learning are also included as two causal conditions for innovation capacity development.

EMPIRICAL RESULTS AND ANALYSIS

Case study results

The study is based on the empirical analysis of two domestic and two global linked value chains.

A.Kafa Forest Coffee Union (KFCU)

KFCU was established in 2004 with assistance from Sustainable Poverty Alleviation in Kafa(SUPAK), a national NGO promoting poverty alleviation in the Kafa zone. KFCU started operations by reorganizing the working methods of 4,200 farmers into a farmers' union. These farmers were already part of cooperatives and had supplied green coffee beans to the national coffee auction (graded as Jimma 5) since 1985.In 2001 the government changed the policy requirement of cooperatives to sell their coffee to the national auction and freed them to directly export their product to foreign markets. This allowed farmers to manage their own coffee production and retain market benefits. The union is a member of the regional federation of farmers and coffee producers and coffee exporters association. Through the support of the Agricultural Cooperative Ethiopia program of VOCA-USAID, which focused on strengthening cooperatives, the membership of KFCU increased by 2010to 6,493 farmers, organized in 26 cooperatives. By the end of 2015, the number of cooperatives increased to 43, with 10,583 members. ACE-VOCA was a project run and financed by USAID from 2004 to 2005. Under this project; the farmers were gradually organized through collective action. The VOCA and the SUPAK projects enhanced the access of KFCU to the export market. These projects not only facilitated strategic alliances with foreign buyers, but restructured the organization of KFCU's production chain to one that is more transparent and traceable and has few intermediaries. The projects provided initial financial capital and market information.

The first importer of forest coffee from KFCU was Original Foods. They had the idea of differentiating the product as a natural forest product. The product differentiation helped KFCU to obtain its own brand name called forest coffee. KFCU received great support in marketing its forest coffee (e.g., wild coffee) by GEO Magazine and GEO TV. In addition, executives and staff from the union have participated in meetings and exhibitions in the international market, as well as using websites and brochures, to promote forest coffee. The support and investment of the GTZ-Public-Private Partnership project team established the cup tasting laboratory and trained the staff on cup tasting skills for KFCU. Although significant improvement in the quality of coffee in KFCU was observed, it did not reach its best quality level. In 2010, about 76% of the member cooperatives of KFCU had obtained group organic and fair-trade certifications.

In 2009, with the support of TechnoServe Ethiopia (financed by the Bill Gates Foundation), three cooperatives (i.e., Diri, Kuti and Wodyo) introduced wet-processing machinery. By 2015, the union had seven wet coffee washing stations and was also in the process of establishing an additional nine washing stations around member cooperatives. The introduction of such technology contributed to improving the quality of the coffee, as wet-processed coffee has better quality than dry-processed coffee. Original Food and Kraft Foods from Germany contributed to introduce in KFCU a new packing system according to international standards.

The GTZ-Public-Private Partnership project team promoted the sustainable use and conservation of forest resources through the adoption of green practices. In addition, KFCU has introduced new forest management practices (i.e., forest management plans) and training in participatory forest management, as well as establishing local management networks for forests and designing scientific methods for assessing, monitoring and evaluating forest use and conservation. These were just some of the eco-innovation practices accomplished in this chain.

Most of the farmers engaged in picking up only red cherries over the last two years. First, the unannounced follow-up and monitoring of cooperatives and development agents also contributed to an improvement in quality. Second, the support and supply of tools and materials such as mesh wire and raised beds from the projects in drying coffee helped a significant number of farmers to introduce and use improved drying methods. Some farmers have introduced and used beds made from local material such as bamboo. The improvement in coffee drying methods enhanced the quality of coffee. Third, the collaboration with a private processing firm (i.e. outsourcing processing activities) has improved product quality. The cooperatives deliver their coffee product to a private dry coffee processing plant where the union has storage facilities and one quality testing facility to support these activities. The cooperation between the union and processing firm enabled the union to deliver the processed coffee to a marketing unit in Addis Ababa.

The quality of the coffee product from cooperatives was very poor until 2003. They reaped both red and green raw coffee by stripping them together. More recently, most farmers pick up only red cherries and consequently, major changes have been observed in the quality of coffee from the cooperatives. There is strict follow-up and monitoring not only from cooperatives but also the development agents, as well as the provision of extension and advisory services to farmers and cooperatives. Change in primary processing methods: Drying coffee on the ground had been practiced by all farmers until 2003. There has been a significant change in coffee drying techniques. A significant number of farmers now use mesh wires or raised beds for drying coffee. Some farmers have introduced and used beds made from a local material – bamboo. The improvement in coffee drying methods enhanced the quality of coffee. Change in coffee processing technology: The coffee from cooperatives has conventionally been processed by dry processing methods, with the coffee processing activities outsourced to private dry processing plants. More recently, with support from TechnoServe Ethiopia, three cooperatives have introduced new wet processing machinery. The new wet processing technology help the cooperatives to engage in value adding activities, as wet processed coffee has better quality. By 2015, the union has established its own coffee hulling industry worth 5 million birr and helped to establish seven coffee washing stations around cooperatives, and it is in the process of establishing nine additional coffee washing stations around member cooperatives. Coffee cooperatives have established a new value chain structure and organized a cooperative union that governs the chain through a general assembly, management board, general manager and other staff, and the flow of the chain information system.

They also changed the supply chain management by semi-vertical integration through collective ownership. In addition, strategic chain alliance has been established with foreign buyer partners. The union provides different services to its member cooperatives including marketing, processing and business services. The new forest coffee chain is short, strict in traceability, and more transparent than the conventional coffee chain. The establishment of the cooperative union enabled members to directly export their coffee without involving in the national auction since 2004. This is the result of a policy decision on the part of the government to improve the enabling environment for cooperatives.. KFCCU has established marketing networks both for domestic and foreign markets. In addition, numbers of forest coffee cooperatives have gained group certification from certifiers. Two type of certification, FLO (fair trade) and IMO (organic) group certifications have helped the cooperatives/ union to access global niche markets since 2004. The operational procedure of supply chain management (traceability) has significantly improved. Moreover, the forest coffee product has been promoted using different promotional mixes. In particular, the promotion of wild coffee by GEO Magazine with the Geo-TV crew has contributed much to its recognition in international markets. The union has also introduced a new packing system that follows the standards and key marks as agreed with its customers. Apart from that, the union has claimed ownership of its brand name "forest coffee." New distributional channels have been established for regional and national markets. Moreover, the union has formed long lasting business relations with coffee buyers in different countries. With regard to economic sustainability, the capital of the union has increased from 200,000 Birr in 2004 to 10.2 million Birr in 2015. The union has earned total net profit of 20.86 million Birr over the last seven years with no loan default history.

New environmental management tools have been introduced. The forest coffee value chain included the environmental issue as an opportunity in its business and changed institutions, the chain structure and the flow of information system. The establishment of forest management groups and networks, preparation and implementation of forest management plans and application of new monitoring and evaluation techniques are new organizational forms that targets achieving forest sustainability. Value chain management has been strictly implemented. Internal control systems and traceability are key tools for value chain management. The certification and eco-label scheme has been used for management, monitoring and evaluation of the sustainability of the value chain and forest resources. As for the contribution to forest and environmental sustainability, KFCU has participated in the effort to conserve natural forests in the Kafa Zone since 2007 in collaboration with different projects and has established and supported Participatory Forest Management systems (PFMs). It has established 49 participatory forest management groups that integrate 19,591 forest users (47% female) occupying 36,847 hectares of natural forest area. Training for PFM and cooperative members on environmental issues has been provided. It also established and supported youth reproductive health (RH) clubs in order to disseminate RH knowledge, provide services and supply materials to reduce population pressure on the forests.

Table 6:
Annual domestic and export sales of KFCU chain (2004-2015)

Year	Sundried coffee				Washed coffee			
	Export		Local		Export		Local	
	Volume (ton)	Value (USD)	Volume (ton)	Value (Birr)	Volume (ton)	Value (USD)	Volume (ton)	Value (Birr)
2004	108		30.8					
2005	108		95.4					
2006	114		15					
2007	89							
2008	90		151.4					
2009	200		179.9					
2011	36	232,871.9	9.3	544,726.8	18	121,032.5	-	
2012	209.7	1,027,619.68	16.1	674,875.9	78.1	577,702.1	3.9	133,886
2013	90	406,748.70	54.6	2,667,454.8	25.2	170,239.2	-	
2014	162	713,496.75	22.1	1,475,774	75.6	462,542.72	-	
2015	126	277,719.60	49.8	2,513,173	37.2	253,176.3	-	

Source: KFCU database, 2015

Bench Maji Forest Coffee Cooperative Union (BMFCU)

BMFCU was established through the integration of 14 cooperatives with 4,948 members of with initial capital of 201,000 ETB in 2005 by the cooperative promotion office in the Bench Maji zone. The member forest coffee cooperatives were initially set up in 1986 and they engaged in production, processing and purchasing the sundried coffee from individual farmers and delivered and sold it in the national auction in Addis Ababa for over two decades. The cooperative promotion office in the Bench Maji zone had engaged in restructuring these cooperatives and organizing new ones to enable them to actively participate in the free market economic system and to cut the transaction expense and gain bargaining power by pooling their resources, knowledge and property.

Two projects were implemented to support the innovation processes in BMFCU. The NTFP Southwest project has helped the member cooperatives to improve coffee production, processing and marketing opportunities by providing training in business skill development, cooperative principles and management, accounting and bookkeeping for the cooperatives and union as well as training in new production and processing techniques for farmers. The NTFP southwest project also helped theAman and Gizmeret cooperatives to get Utz Kapeh and organic standards certification in 2005. However, these certifications failed to attract potential foreign buyers to the union, so activities for further renewals of these certifications and certification of other cooperatives were not done. With regard to sustainable forest management and conservation, the NTFP Southwest project established a community forest conservation group in the Shako district. The second phase of this project entailed establishing two participatory forest management groups (Kubata & Keritika community forest management organizations) in the Shako district in 2010. The USAID/Fintrac coffee support project, on the other hand, financed innovation projects, organized project teams and generated and disseminated knowledge and information for innovation practices. The USAID/FINTRAC project helped provide materials and tools such as drying beds, wire mesh and handcarts to farmers as well as establishing a cupping laboratory and supplying moisture content testing tools at the union level. The project team and farmers conducted a joint demonstration on good quality production techniques to facilitate the transfer of tacit knowledge to farmers. The USAID-ATEP has provided training on both harvesting and post-harvest management techniques for forest coffee producers, collectors and processors. Training was given on subjects like harvesting, sorting and grading, and on drying and storage techniques as well as cup testing techniques.

The interview conducted with Mr. Endale Aredawu, the General Manager of BMFCU, showed that the union achieved only incremental improvement in product quality although it supplies both sundried and washed coffee products to the market. This is highly linked with the use of obsolete processing technology that has no spare parts in domestic markets, lack of supply of necessary materials such as drying beds and packaging sacks and the use of an unhygienic logistics and transportation system. In fact, the differentiation of the product from the mainstream coffee chain was achieved. The interview also revealed that incremental change was achieved in chain development. The cooperatives have an umbrella organization, the union which led the chain in domestic market. But although 25 cooperatives are organized and have joined the union; only six cooperatives are active in delivering coffee to the union. We also conducted an interview with Mr. Getahun Tekle, the marketing officer of BMFCU, who indicated that BMFCU failed to introduce market capability, i.e. to penetrate new markets, due to the lack of a strategic buyer partner. With support from the NTFP project the union established a linkage with local private processor and exporter and made sample exports of 33 and 18 tons of its coffee to Belgium and earned 791.1 thousand and 682.6 thousand ETB in 2007 and 2009, respectively. This was interrupted soon after initial contact, however, due to mistrust between them. Most forest coffee delivered to the union is sold in the domestic market. Similarly, the introduction of eco-innovation to Bench Maji zone is insignificant. Introduction and enforcement of a certification & eco-label scheme, property right partition, environmental management tools and environmental regulation are rarely practiced in this value chain.

Table 7
Sale of forest coffee of BMFCU by market& product type, 2005-2015

Year/market	Domestic				Export	
	Washed		Sundried		Washed	
	Volume (tons)	Sale (in thousand Birr)	Volume (tons)	Sale(Birr)	Volume (tons)	Sale (Birr)
2005					33	791,200
2007	61.9	195,100			18	682,600
2008	72	1,982,000			-	
					-	
2009	32.04	1,044,000	12.07	296,084	-	
2012	91,200.00	5,891,557.70				
2013	55,988.00	2,762,349.50				
2014	201,690.00	19,802,700.84				
2015	25,940.25	3,393,071.81				

Source: Bench Maji forest coffee union reports

Kafa Forest Honey Union (KFHU)

KFHU is an umbrella organization linking honey and beeswax producers in the Kafa zone to domestic markets. Currently, it has seven honey and beeswax producers' cooperative members. The number of members was 1,035 in 2008, of which 104 were female members. There were significant increases in membership, reaching a total of 1,656 in 2010.

Two projects have engaged in innovation activities to establish this chain. These are the Community Initiative Promotion Project (CIP) and SNV Ethiopia honey and beeswax value chain development. Major innovation activities of these projects were establishing public-private partnerships with heterogeneous actors, empowering minorities and women, improving social relationships between partners, organizing disadvantaged social groups (women, minority Manija groups), building trust and commitment, identifying joint problems and developing a shared vision, and building a collective organization. Other key activities of the projects were establishing a community business enterprise (cooperative) and vertical links with the umbrella organization (union); conducting a number of entrepreneurship orientation activities (cross-visits to similar cooperatives, awareness creation, a workshop to share knowledge and experiences); and providing training for beekeepers in production, harvesting and processing honey and beeswax. Enhancing the social learning processes through using selected innovation champions within communities, among cross-visits to similar smallholders' cooperatives, organizing awareness creation workshops and empowering disadvantaged social groups were key tools used in building trust and collaboration among smallholder farmers. In addition, transparent participation in the preparation of cooperative bylaws and in arranging a general assembly and management board created trust and commitment among farmers in order to set up seven collective enterprises that integrated 1,656 small producers and one umbrella union. The establishments of cooperatives and a union (the chain leader) facilitated their direct access to national and regional markets by renewing the management of the value chain. These projects also improved access to a variety of services by cooperatives and the union for farmers, including credit services from microfinance, technical services such as establishing a collection and processing center and marketing and logistic services (storage facilities, distribution channels and different packing styles).
services (storage facilities, distribution channels and different packing styles).

KFHU now supplies buyers with significantly improved products, i.e. processed honey and processed beeswax that are packaged in three different sizes ranging from 3/4 kilogram to 3kilograms of honey. More than 25% of its producer farmers have started using new production techniques such as using beehives made from NTFP (bamboo) and modern harvesting and post-harvest handling techniques, unlike bringing chunk honey in jars. The cooperatives engage in processing bee products using 32 processing centers and collect honey products harvested by farmers within 24 hours, while the union extracts honey using electrical extracting equipment from bee products harvested by farmers and stored longer than one day. But the quality of products is not yet developed for export markets due to the high moisture content of the honey product.

Changes have been made to the structure and organization of the honey value chain, and now it is managed by new rules (bylaws) and board members chosen in a democratic manner from member cooperatives. Cooperative development is one of the institutional changes that enhanced the bargaining power of poor producers; reduced transaction costs by establishing 32 collection and processing centers in the vicinity for producers; and established linkages with associations at the national level such as EHBPA and EHPEA for access to markets, relevant knowledge and information and with Addis Ababa plastic factory for the supply of packaging materials.

Honey from Kafa has obtained a new brand, namely forest honey. This product differentiation strategy is not based on the final product but rather on the types of flowers and their sources (natural forest). Unlike the conventional marketing methods through personal contacts, promotions of forest honey have been conducted using mixes of promotion methods. Four promotion campaigns have been conducted through TV and radio. In addition, promotions through written materials such as brochures and leaflets are also carried out. Promotion of forest honey is further done through participating in exhibitions in Hawasa and Dire Dawa towns. Participation in international trade fairs and sending sample products to companies in foreign countries including Norway and The Netherlands are other methods used to promote the product. In addition, new distribution channels were established for regional and national markets. The union has established four selling branches in main capital cities (Addis Ababa, Hawasa, Bonga and Bahir Dar) that distribute and sell its products to supermarkets, hotels, bars, consumers and organizational clients. Further, the union now uses new packaging materials (plastic) and has introduced three different packaging sizes.

Table 8
Production and sale by KFHU

Year	Unprocessed Honey		Processed Honey		Processed Beeswax	
	Volume	Sale(Birr)	Volume	Sale(Birr)	Volume	Sale(Birr)
2008	19952	379088	4004	106106	89	3204
2009	20144	382736	8983	238049.5	310	11160
Growth (%)		1		124		248

Source: KFHU Reports

D. NTFP Cooperative Apinec PLC Chain

Apinec PLC is a joint venture company established in 2004 between Apinec Apiculture Development and Trading, Trichilla ABC and Clootwijk Apiaries BV (Gebremariam, Bekele, & Ridgewell, 2009). The generation of ideas and exchange of information through interactions between two Ethiopians and foreigners which were later supported by research and studies were key to the genesis of the Apenic PLC. The company engages in the production, processing and marketing of organic honey/ wax and other non-timber forest products including forest (organic) coffee and Ethiopian cardamom. It has 100 hectares of nuclear farm plots in the Kafa zone and engages in the cultivation of organic honey in its own farm plots. The company produces a minimum of 80 tons of honey from its own 2,000 modern hives. In addition, it aims to contribute to sustainable management and use of natural forests in southwest Ethiopia.

Four initiatives that were involved in promoting innovation activities in the forest honey value chain are the Ethiopia honey and beeswax value chain development project, the Community Initiative Promotion Project (CIP), Apenic agro-processing project, and participatory forest management projects. Besides these efforts, the participatory forest management (PFM) project by Farm Africa and SOS Sahel has partnered with the honey and beeswax value chain development project by SNV Ethiopia to achieve innovation in this chain. Major project activities include the establishment of multi-stakeholder platforms (coordination committee) consisting of 28 organizations from seven different honey sector-related fields of activities; generation of new ideas, knowledge and approaches through organizing workshops, seminars and meetings; introduction of sectoral institutional changes through establishing new structures and organization in the apiculture sector at various governance levels with the provision of new regulations, policy plans and institutional arrangements with the EU for accreditation of third country listings.

The Apenic PLC has engaged in a business partnership with 14 forest conservation and multipurpose cooperatives including more than 1,270 small farmers and more than 1,240 out-grower farmers. They agreed and entered into a contractual agreement with the company to supply a better quality of honey with 19.5% moisture content at the current market price. The farmer cooperatives and out-growers supply the bulk of 220 tons of honey product per annum. In the regional processing center, the company uses modern and advanced product processing technology, moisture reduction equipment that adjusts the moisture content to a standard level, flower testing equipment and a modern beeswax extracting machine.

Moreover, an interactive learning process was promoted using different mechanisms. First, they have not only facilitated the establishment of different stakeholder groups at different layers but also their linkages by coordinating a multilayer stakeholder forum (innovation platform). The involvement of diverse stakeholders (28 organizations from seven different areas of activities) in the innovation platform have created a space for interactions that enhance social learning, reduce conflicts, build trust and lead to coordination and joint action. The platform includes diverse stakeholders from both private and public domains with different backgrounds from local, regional, national and even global levels. Second, a number of workshops, seminars and meetings were organized, serving as important sources of new ideas, knowledge and approaches to identify and solve problems along honey and beeswax value chain. Third, the provision of professional advice to project teams and support for research activities is another important mechanism for transferring and acquiring knowledge. The projects have also made tremendous efforts to build the innovation capacity of community enterprises. First, they have provided training for member farmers and cooperative management on various subjects such as on technical, managerial, business and marketing skills. Second, the projects as well as the company provide embedded services such as access to a variety of technical, businesses and financial loan services free of interest charges to their suppliers. For instance, the Apinec PLC provided financial loans up to 200,000 Ethiopian Birr (ETB) free of interest charges in 2010. The chain structure is easy and very short. Third, these projects have supplied important tools and implements for production and harvesting and established a joint collection and processing center and equipped it with necessary facilities and equipment, as well as joint storage facilities in their vicinity. Fourth, the market orientation activities of projects have developed the marketing capability of community enterprises. The generation of market intelligence and dissemination of it along the value chain, product differentiation, and inclusion of customer insight in the marketing strategy, expansion of distribution channels and use of different market promotional mechanisms have contributed to an increase in marketing capability.

The NTFP cooperative Apinec PLC chain introduced both significantly improved products (organic mono and poly floral liquid honey and organic beeswax) as well as new products such as propolis and medicinal honey from stingless bees for the export market. Nearly half of the producers use a modern production system and a better harvesting system that helped them to bring comb honey to regional processing centers. Some of the farmers have engaged in construction of their beehives while other farmers have been able to transfer bees from three traditional beehives to one modern hive.

Different organizations have been developed in the apiculture sector at various governance levels. Organizational developments at the federal level include a multi-stakeholders forum (CG), an apiculture health and safety regulation department, the Apiculture Research Institute, the Ethiopian Honey Bee Producers and Exporters Association, the National Apiculture Board, and the Apiculture Resource Development Inspection Authority with their respective plans, policies and regulations. In addition to these sectoral institutional changes, institutional arrangements made with the EU and other countries are new relationships. New forest management groups and networks were established. Devolution of management of forests to communities and new institutional arrangements (contracts) with forest management groups were made. In addition, preparation and implementation of forest management plans and application of new monitoring and evaluation techniques are new organizational forms aimed at achieving forest sustainability. Internal control systems, traceability and an organic certification and eco-label scheme are key tools for value chain management that directly contribute to the sustainability of the environment and value chain.

Table 9
Exports by NTFP Cooperative Apenic PLC Chain

YEAR	Type of product	Gross Wt. (Kg)	Net Wt. (Kg)	FOB Value(ETB)	Destination
2012	Beeswax	12,186.70	12,000.00	1,241,345.00	Netherlands
2011	Natural honey	41,072.00	39,995.00	2,658,481.93	Norway
2012	Natural honey	111,991.25	107,991.25	7,620,633.86	Norway
2013	Natural honey	166,885.50	162,361.50	12,115,093.68	Japan, Norway
2014	Natural honey	41,086.00	40,000.00	2,385,120.00	Norway
2015	Natural honey	41,072.00	40,000.00	2,494,338.00	Norway

Source: Apenic PLC Reports

Fuzzy comprehensive evaluation results for innovation capacity

Table 10 presents the final results of the third fuzzy comprehensive evaluation for the four cases. The results show that the innovation capacity of the value chains ranges from a high of 3.9 for NTFP cooperative Apenic PLC chain to a low of 2.44 for Bench Maji forest coffee union chain. The result for the NTFP cooperative Apenic PLC chain shows that it achieved an innovation capacity score of 3.91, indicating that this chain has achieved on average 78% of all the dimensions of innovation practices, with varying performance on various components of innovation practices ranging from a high of 83% to a low of 72%.The chain performed better (80-83%) than the average performance level on several components of innovation practices, including training and competence building, global institutional arrangements, local institutional reform and policy support , chain collaboration and strategic alignment. Because of this better performance of the components, this chain achieved a good level of innovation capacity.

The result for the Kafa Forest Coffee Union chain shows that the computed level of innovation capability was 3.31, which reflects that this chain achieved about 66% on average of all dimensions of innovation practices, with varying performance on components of innovation practices ranging from the lowest on technology upgrading (53.5%) to the highest on local institutional reform and policy support (82.4%). The results showed that its performance on five components of innovation capacity were higher than the average performance. The result suggests that this chain achieved a good level of innovation capacity over the last five years. The computed innovation capacity for the Kafa Forest Honey Union is 3.12, indicating that it achieved 62.77% on average of all components of innovation capacity with differing achievement on components ranging from the lowest on global institutional arrangements (52%) to the highest on local cluster networking and policy support (67%). The result suggests that the KFHU chain achieved a moderate level of innovation capacity. The level of innovation capacity for the Bench Maji Forest Coffee Union is 2.55, indicating that on average this chain achieved a moderate (49%) level of innovation capacity. The achievements of all components of innovation capacity were less than 50%, with the exception of local institutional reform and policy support (77%).

Figure 2: Performance of innovation practices by NTFP chains

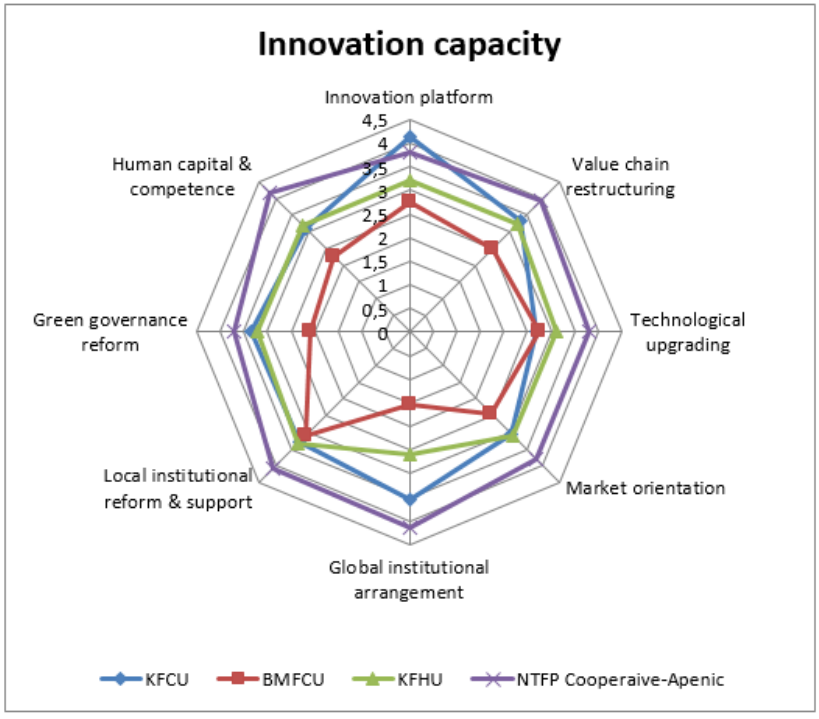

Table 10
Results for innovation capacity and performance in different dimensions

No	DIMENSIONS	KFCU		BMFCU		KFHU		NTFP Cooperative Apenic PLC	
		performance	%	performance	%	performance	%	performance	%
1	Innovation platform learning	0.513	83	0.338	55	0.393	64	0.466	76
2	Value chain restructuring	0.426	67	0.317	50	0.40	65	0.49	79
3	Technological upgrading	0.34	54	0.347	55	0.39	62	0.48	76
4	Market orientation	0.376	61	0.303	49	0.389	62	0.477	76
5	Global institutional arrangements	0.424	71	0.184	31	0.323	52	0.509	83
6	Local institutional reform and policy support	0.436	66	0.407	62	0.43	67	0.526	82
7	Green governance reforms	0.427	67	0.407	42	0.406	64	0.471	74
8	Human capital/competence	0.37	62	0.267	45	0.413	64	0.499	83
	Innovation capacity	3.312	66	2.44	49	3.13	63	3.91	78

Result for fuzzy set qualitative comparative analysis (fsQCA)

The result from running fsQCA in Stata 14 is presented as follow. The configuration QBTG accounts for 75%, while the configuration QbTg accounts for 25%. Innovation platform learning, value chain restructuring, technology upgrading and green governance reform are represented byQ,B,T and G, respectively.

Table 11
Innovation Capacity and aggregated Causal Conditions

Cases	Innovation Capacity	Innovation Platform	value chain restructuring	Technological upgrading	Green governance Reforms
KFCU	0.66	0.83	0.66	0.61	0.67
BMFCU	0.49	0.55	0.44	0.52	0.42
KFHU	0.63	0.64	0.6	0.64	0.64
NTFP Cooperative -Apenic PLC	0.78	0.76	0.79	0.8	0.74

The result from running fsQCA in Stata 14 is presented as follow. The configuration QBTG accounts for 75% while configuration QbTg accounts for25%. Innovation platform learning, value chain restructuring, technology upgrading and green governance reform are represented by Q, B,T, and G, respectively

Tabulate best fit

bestfit	Freq.	Percent	Cum.
QBTG	3	75.00	75.00
QbTg	1	25.00	100.00
Total	4	100.00	

. fuzzy C Q B T G,matx (coincidsuffnec) standardized

Coincidence Matrix

	C	Q	B	T	G
C	1.000				
Q	0.992	1.000			
B	0.996	0.988	1.000		
T	0.980	0.984	0.980	1.000	
G	0.992	1.000	0.980	0.976	1.000

Sufficiency and Necessity Matrix

	C	Q	B	T	G
C	1.000	0.992	0.969	0.980	0.957
Q	0.914	1.000	0.885	0.910	0.888
B	0.996	0.988	1.000	0.980	0.972
T	0.977	0.984	0.949	1.000	0.938
G	0.992	1.000	0.980	0.976	1.000

. fuzzy C Q B T G,settest (yvvyvn) sigonly greater(coll) conval (.700) common

Y-CONSISTENCY vs N-CONSISTENCY

Set	YConsNCons	F	P	NumBestFit
QBTG	1.000	0.570	10.53	0.048	3

Y-Consistency vs. Set Value

Set	YConsist	Set Value	F	P	NumBestFit
QbTg	0.979	0.700	241.17	0.001	1

Final Reduction Set

Coverage

Set	Raw Coverage	Unique Coverage	Solution Consistency
Q*T*G	0.938	0.012	0.996
Q*B*T	0.941	0.016	1.000
Q*B*G	0.945	0.020	1.000

Total Coverage = 0.973

Solution Consistency = 0.996

The coincidence result shows that value chain restructuring(B), innovation platform learning (Q), green governance reform(G) and technological upgrading (T) have high coincidence score overlap with outcome and are sufficient for predicting innovation performance. The result also indicates that the configuration QBTG is significantly more consistent than 0.700 at the 0.05 level.

From Minimum Configuration Reduction we have three causal configurations or paths for the outcome to occur. The first path shows that the simultaneous presence of multi-stakeholder partnership platform, technological upgrading and green governance reforms is sufficient for the outcome to occur. The second path is the presence of value chain restructuring, innovation platform learning and technological upgrading, which is also sufficient for the outcome. The third path for building innovation capacity is innovation platform learning, green governance reform and value chain restructuring. The solution has coverage of 0.97 and consistence of 0.99, indicating that the model has high empirical significance. The result indicates that a multi-stakeholder partnership (innovation platform) is common for the three paths, indicating that it is a necessary condition for development of innovation capacity in a sustainable value chain.

Discussion and Implications

The main findings and implications of the study are discussed as follows. First, the results reveal that the simultaneous presence of value chain restructuring, technological upgrading innovation platform and green governance reforms is more effective than their absence for developing innovation capacity in a sustainable value chain. This finding implies that the use of a holistic or integrated approach for addressing combinations of conditions outperforms the use of a single capacity building approach. We also find that multi-stakeholder partnership is necessary condition for outstanding innovation capacity in value chain.

Second, engagement with innovation platform learning is crucial for achieving a higher level of innovation capacity. The results demonstrate that those local clusters which have linkage with innovation platform (IP) have achieved higher level of innovation capacity outcomes. Public-private partnership, for example, has facilitated the collective actions of partners in the apiculture sub-sector and established institutions at micro, meso and macro levels. By contrast, Bench Maji forest coffee union that engaged with few projects has a lowest degree of innovation capacity. The key implication of this result is that building innovation platform at various levels, forming linkage with various social, economic and knowledge sector could make community forest based firm had more innovative capacity than government actors alone could do.

The degree of value chain restructuring is one of the key causal conditions for innovation capacity development. Value chain restructuring consists of market orientation, global institutional arrangements and value chain relations. The result suggests that the creation of relationships with downstream chain actors substantially improves the degree of innovation capacity. However, the degree of improvement in the level of innovation capacity depends upon the types of chain relationships. Formation of linkages with a vertically integrated joint venture achieves a higher degree of innovation capacity than formation of strategic alliance with a foreign buyer partner. This difference might arise from the fact that formation of a partnership with a joint venture may have a tight alignment of chain operation, access to and acquisition and use of market intelligence, state of the art technology and provision of embedded services to its suppliers. The implication of this finding is that the organizational improvement of farmer cooperatives by establishing a union is not sufficient for achieving a higher degree of innovation capacity. Given the fragmented chain structure and existence of mistrust between actors along value chains, this finding suggests that the coordination of actors along the entire value chain is necessary for building trust commitment and promoting joint action and collaboration. As part of value chain restructuring, market orientation is one of the key causal conditions for building innovation capacity. The collection and use of market information, establishing market networks, market promotion and the involvement of buyers in promoting innovation are key activities for building innovation capacity. The results revealed that export-oriented and buyer linked value chains have achieved a higher degree of innovation capacity than domestic value chains. The export market orientation may require the removal of entry barriers and international institutional arrangements, which in turn necessitates capacity building for upstream chain actors and changes in institutions.

Green governance reform is one of the causal conditions for promoting innovation capacity in value chains. The adoption of greening practices facilitated changes in existing local practices, establishment of new institutions and interaction with global knowledge and practices. The findings demonstrate that those value chains that adopted CSR – for example, NTFP cooperative Apenic PLC and KFCU– have achieved a higher degree of innovation capacity, implying that adoption of a CSR scheme and green governance can not only facilitate access to global markets but also build innovation capacity of upstream actors through improving monitoring and compliance capability, promoting changes in existing practices and transferring global knowledge. Certification and community-government forest management partnerships are important tools for green governance reforms.

The study, moreover, indicated that the presence of technological upgrading is an important condition for a high degree of innovation capacity. Results indicated that the acquisition and use of advanced techniques have a significant effect on innovation capacity building. This effect, however, depends on the strategies applied for acquisition and use of technology. The finding showed that strategic alliance with a joint venture (local–global linkage) has a higher effect on improving innovation capacity, which is followed by linkage with a local private processing firm or establishment of a jointly owned community processing firm. The result indicated that technological upgrading through government technology support brings a lower level of improvement in technological efforts. This suggests that the formation of linkage with a private processing firm (local /global) is a superior strategy for building innovation capacity through acquiring and using state of the art technology. As part of technological upgrading, competence building and human capital formation is one of the key strategies for innovation capacity development. The finding of the study shows that those value chains that focus only on building technical skill– for example, the Bench Maji case – have a low level of innovation capacity, implying that building both technical, managerial and business skills is crucial for achieving superior innovation capacity. It also showed that combining different methods such as visiting for experience sharing; training and education; hiring/transferring qualified personnel to a partner company; and participatory demonstration of new technology with support from technology gate keepers (technicians) are more appropriate in developing human capital and competence than using a single method.

The findings of the study, furthermore, showed that support and policy measures of the government have played a key role in building innovation capacity through cluster and network development, establishing/changing vital institutions, hiring or transferring qualified human resources for extension and advisory services, facilitating financial capital, and soon. However, the effectiveness and appropriateness of support and policy measures insignificantly different between producers for the domestic market and producers for export markets. The support and policy measures of government were more favorable for producers targeting export markets than for producers for domestic markets. This result implies that there is significant policy discrimination between investors for satisfying domestic demand and investors for export markets. Given the availability of high domestic market demand and poor market structure in the country, this finding suggests that government needs to give at least equivalent attention in supporting innovators for domestic and export markets.

As for the measurement of degree innovation capacity, the result indicated that the degree of innovation capacity is determined by the breadth, depth and integration of eight dimensions, which were aggregated into four causal conditions for identifying necessary conditions. These dimensions are innovation platform learning, value chain restructuring, human skill and competency building, technological upgrading, global institutional arrangement, market orientation, local and global institutional arrangements and support, and green governance reforms. This study indicates that, in addition to in-depth qualitative case study, the application of a fuzzy comprehensive evaluation model provide broader insights that are important not only for measuring the current degree of innovation capacity in a supply chain but also for identifying strengths and weakness areas as well as guiding the direction for introducing innovation in the value chain. By developing and applying a fuzzy comprehensive evaluation model for measuring value chain innovation capacity and fuzzy set qualitative comparative analysis for identifying necessary and sufficient conditions for innovation capacity development in a sustainable value chain, this study makes an important methodological contribution to existing innovation literature. Examining how different dimensions of innovation capacity relates to the major value chain performance metrics such as distributive fairness, efficiency and profitability for stakeholders at different chain level will be research agenda for future.

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