International Food and Agribusiness Management Review
Volume 17 Special Issue 1, 2014

The Impact of Public R&D on Marketing and Supply Chains on Small Farms' Market Sensing Capability: Evidence from the Australian Seafood Industry

Domenico Dentoni[ⓘa], Francis English[b] and Daniela Schwarz[c]

[a]*Assistant Professor, Management Studies Group, P.O. Box 8130. 6700 EW, Hollandsweg 1 Wageningen, 6707KN, The Netherlands*

[b]*Researcher, Agriculture, Food and Wine, University of Adelaide, North Terrace, Adelaide, South Australia, 5000, Australia*

[c]*Graduate Student, Marketing and Supply Chains, University of Sunshine Coast, Queensland, Australia*

Abstract

Agri-food organizations that are capable of "sensing the market" – that is, capable of searching, processing and using market information, are usually also market oriented, innovative, entrepreneurial and successful. But how can a small farm with limited resources develop market sensing capabilities? This research explores when public Research & Development (R&D) has an impact on small farms' market sensing capabilities. The literature on the impact of public R&D on small farms' market orientation is limited despite the importance of the topic for regional competitiveness and economic development. This research follows an inductive "grounded theory" approach of investigation. Qualitative and quantitative data is collected from five cases of public-private R&D projects funded by the Australian Seafood Cooperative Research Centre (CRC). One "typical" in-depth case study of an R&D project in the oyster sector provide empirical evidence for cross-case comparison and structural equation modeling (SEM). Findings highlight the provision of R&D market information on estimated prices and quantities, end users' lower initial capabilities and higher discipline clarity, and the absence of industry associations undertaking marketing roles for farmers to enhance the impact of public R&D on small farmers' market sensing.

Keywords: market-sensing, capabilities, grounded theory, structural equation modeling, public R&D, oysters, seafood

ⓘCorresponding author: Tel: +31. 646801736
Email: D. Dentoni: domenico.dentoni@wur.nl

To compete and survive in dynamic markets where consumer needs, buyer requirements, competitive and stakeholder pressures change rapidly, managers of food companies are pushed to become market oriented, that is, more adaptive to opportunities and threats coming from the market (Kohli and Jaworski 1990). For small farmers this is particularly challenging, as they have limited resources to access updated market information, absorbing knowledge and make changes based on the result of learning. So far, research analyzed the positive impact of small farms' market orientation (Martin et al. 2009) on their entrepreneurial orientation (Holster 2008) and innovation (Verhees 2005), and ultimately on their performance (Micheels and Gow 2008). Much less research is available on how organizations - including small farms - can become market-oriented (Anderson and Narus 2007). A crucial capability that makes organizations market oriented is *market sensing*, which is the attitude and ability of searching, processing and using market information (Day 1994).

Through dissemination of results of value chain analysis and consumer studies, public and public-private R&D (in this paper conveniently named public R&D even if sometimes have a participation of private funding) institutions attempt to stimulate market-driven innovations in pre-competitive settings (Pandey et al. 2013). For small farmers, this is an opportunity to innovate based on updated market information and to activate a "double-loop learning" (Argyris 1997), that is, to "learn how to learn" new market information on their own. In other words, small farmers have an opportunity to develop market sensing capabilities from public R&D results of marketing and value chain analysis (Capitanio 2009; Klerkx 2010). Ultimately, public R&D that is able to stimulate small farms' market orientation increases regional competitiveness, economic development and food security (Dentoni and Reardon 2010; Link and Scott 2013). Despite the managerial and policy importance of the topic, so far few empirical studies analyzed *when* public R&D has an impact on small actors' capabilities (Wanzenböck et al. 2012). Among these few studies, none explored the R&D impact on market sensing in the agricultural and food sector. To start filling this gap, this research explores *under which conditions public R&D has an impact on small farms' market sensing capabilities,* including characteristics of the individual R&D end users, of their industry associations, and of the R&D research and dissemination methods used.

Given the gap in the literature and the importance of the topic, we follow a "grounded theory" method of investigation (Glaser and Strauss 1967; Eisenhardt 1989) based on the case of the oyster value chain analysis project funded by the Australian Seafood Cooperative Research Centre (CRC). We collect quantitative and qualitative data to gain rich insights on the cause-effect relationship among variables (Eisenhardt 1989; Birkinshaw et al. 2011). For the qualitative component of the work, we compare and contrast semi-structured interviews 1) with an initial sample of 45 small oyster farmers, half of them involved in a CRC project analyzing the oyster value chain and 2) across project stakeholders in five similar projects funded by the Seafood and Beef CRC in the wild prawn, farmed prawn, finfish and beef sectors. For the quantitative component, we use SEM to analyze relationships between receiving market information through the R&D project, farmers' beliefs and attitudes towards the R&D project results, and their market-sensing capabilities. As quantitative data are collected from 34 oyster farmers only, results are exploratory and leading to the statement of testable propositions as opposed to confirmatory hypotheses-testing.

The paper is organized as follows. Section 2, the theory introducing and linking the concepts of firms' market-sensing capability, market orientation, innovation and performance are explored. In section 3 the research methods are presented and followed by a selected background in section 4. In section 5, the results from the quantitative survey are presented and integrated with the qualitative evidence collected. In section 6, the discussion session introduces the conceptual framework formed by the set of testable propositions and based on the results. Section 7 provides the conclusions.

Literature Review

Market Sensing Capabilities, Market Orientation and Competitiveness

A large number of empirical studies have recently explored how food companies increased their competitiveness by becoming more market oriented (Grunert et al. 2005; Beverland and Lindgreen 2007; Lankinnen et al. 2007; Martin et al. 2009), entrepreneurial (Knudson et al. 2004; Holster 2008) and innovative (Verhees 2005; Sankaran and Mouly 2006; Trienekens, 2008; Vogels 2008; Micheels and Gow 2008). Yet, an open debate in academia, business and policy-making is how agricultural and food firms can become market-oriented and innovative (Anderson & Narus 2007). In fact, a number of public R&D programs and public-private partnerships worldwide aim to enhance agri-food companies' market orientation and innovation (Allen 1999).

A seminal work in this area identified the firm capabilities of *market sensing* and *customer-linking* as drivers of market orientation and ultimately competitiveness (Day 1994). Building upon Kohli and Jaworski (1990) market orientation's model, Day (1994) describes market sensing as the capacity to gather market information, including information about customers, competitors and other chain members, distribute it effectively across an organization and consequently exploit a commercial and competitive benefit from possessing and correctly using this information. It is important for a firm to have a good understanding of its market(s) and what its customers are demanding. Without this understanding it would be difficult to operate an efficient business producing products or services which meet the needs of the end users. Market sensing may be the result of a market driven culture in a particular organization. Thus, rather than being a behavior, market sensing is rather an existing culture or thought process which highly values the benefits of market information and actively seeks to exploit the competitive advantage that this information may allow for (Day 1994). By empirically testing Day's theory (1994), Lindblom et al. (2008) found that market sensing is strongly related to market orientation, yet not to business profitability. This implies that, even though a business may have good market-sensing capabilities, other independent factors may limit leveraging market orientation to achieve profitability. Furthermore, the conditions under which market-sensing has an impact on market orientation were studied by Olavarrieta and Friedman (2008). In an empirical study of publicly traded Chilean firms they found that market orientation and the possession of market sensing skills is very significant to overall business performance and innovation.

Together with market sensing, customer-linking capabilities are also key drivers of a firm market orientation (Day 1994). Customer-linking refers to the organizational ability of "creating and

managing close customer relationships" (Day 1994). Historically many businesses have focused simply upon the transaction taking place with little consideration for the quality and/or establishment of a mutually beneficial and long-standing relationship between seller and buyer. This is very pertinent in the agricultural context as the market has moved from a 'push' to a 'pull' interaction with customers where the focus has shifted away from producers supplying whatever is on offer to being forced to listen to the demand of customers ('pull') and tailor their production to meet these demands. Customer linking capabilities are important in order to build a loyal customer base, increase customer satisfaction and profitability of a business (Hooley et al, 2005). Thus it is another key driver for a firm to be market oriented. This along with market sensing capabilities lead to firms being market oriented which allows them to serve their customers in the most efficient and effective way while having a competitive advantage over other firms whose capabilities are not as well developed. The impact of customer-linking on market orientation was analyzed by Rapp et al (2010) and Hooley et al (2005). Hooley et al (2005) found that having good customer linking capabilities had a positive effect on the efficacy and success of a firm to deliver what their customers want. Rapp et al (2010) also found a positive relationship and determined that having close relationships, with open and frank communication, with customers allows a firm to "better understand customer needs and develop appropriate responses to those needs". It should be noted that there are many different types of relationships and particular dynamics across types of agricultural businesses and particular industries and in many cases what constitutes a close relationship is very different and may be hard to measure in a standard format. Compared to the existing literature, our study instead examines the impact of public R&D on value chain analysis on small farmers' market-sensing, and the conditions under which market sensing can be developed.

The Impact of Public R&D on End Users' Capabilities

While the literature has widely studied the impact of public R&D programs on firms' product and process innovation both in the agricultural and other sectors (Allen 1999; Andersen and Song 2013; Pardey et al. 2013), only few studies have so far focused on the impact of public R&D on end users' capabilities (Falk 2007; Clarysse et al. 2009; Hsu et al. 2009; Wanzenböck et al. 2012; Knockaert et al. 2013). Differently from product and process innovation (Cohen and Levinthal 1990), firm capabilities refer to the ability of the organization of redeploying skills, resources and competencies (Teece et al. 1997). This is a relevant and timely area of investigation, because public R&D that has an effective impact on capabilities gives the opportunity to firms to self-sustain their future innovation processes, thus giving the opportunity to reduce the need of public R&D expenditures in the long run. In relation to markets, firms that learn to understand changing patterns at final consumer and buyer level do not need further public R&D investments every time that these changes occur.

The literature on the impact of public R&D on end users' firm capabilities has analyzed when such an effect takes place, yet neither in the agricultural sector nor with specific reference to market sensing. These studies have analyzed how firm, industry and network characteristics enhance the impact of public R&D. First, the effects of firm characteristics on public R&D impact were studied by Falk (2007), Clarysse et al. (2009) and Wanzenböck et al. (2012). In particular, firms that are less experienced in public R&D (Clarysse et al. 2009), younger (Falk 2007; Wanzenböck et al. 2012), smaller and more technologically specialized (Wanzenböck et

al. 2012) learn more from public R&D. Second, the effects of industry characteristics on public R&D impact were studied by Hsu et al. (2009) in Taiwan. In particular, chemical & material firms had the highest levels of learning, electronic & telecommunication and machinery & equipment industry had a significant level, while the biotechnology and pharmacy (B&P) sector had the lowest levels of learning. Thus, overall the more traditional sectors seem to benefit more from public R&D in terms of learning, while the more technology-rich seem to benefit less. Third, the effects of network characteristics on public R&D impact were studied by Clarysse et al. (2009) and Knockaert et al. (2013). In particular, a higher number of external partners in public R&D led to increased learning (Clarysse et al. 2009). Moreover, the presence of intermediaries between the public agencies delivering R&D and the firm enhances firms' chances to develop capabilities from R&D (Knockaert et al. 2013).

Thus, on the one hand literature has analyzed the importance of market-sensing capabilities for market orientation, entrepreneurship, innovation and competitiveness (also in the agricultural and food sector) (Beverland and Lindgreen, 2007; Trienekens, 2008; Micheels and Gow 2008), yet not exploring how to firms can develop market sensing. On the other hand, R&D literature has analyzed how firm, industry and network characteristics enhance public R&D impact on capabilities (Falk 2007; Clarysse et al. 2009; Hsu et al. 2009; Wanzenböck et al. 2012; Knockaert et al. 2013), yet none on market sensing capabilities or in the agricultural and food sector. This leaves a notable gap in the literature on the impact of public R&D on market sensing capabilities, especially considering the large amount of R&D investment in agricultural and food spent worldwide to make small farmers and entrepreneurs more market adaptive.

Research Methods

Grounded Theory

To analyze the conditions that enhance public R&D impact on small farms' market-sensing capabilities in a domain with no theory already developed, we follow a grounded theory approach of investigation (Glaser and Strauss 1967). Grounded theory is an inductive research method based on the development of new hypotheses during the process of data collection and an interpretative work of observation of phenomena. It requires the researchers to be open and find new patterns throughout the process of data collection. The method requires a continuous iteration between the empirical data, the existing theory in the literature and the new theory developed along the process (Eisenhardt 1989). A grounded theory approach is appropriate to be used especially in new domains where theory is still underdeveloped, as in the case studied by this research (Glaser and Strauss 1967; Eisenhardt 1989).

Consistently with the established research design methods on grounded theory (Eisenhardt 1989), we conducted two stages of iterated data collection and analysis, the first broader and unfocused, the second more specific and focused. First, in early 2010 we conducted open interviews with project stakeholders involved in five CRC value chain analysis projects. The goal of the first round on data collection was 1) to understand if the public R&D programs funded by CRC had an impact, thus whether the funding was worth being spent in "learning-oriented activities" for farmers or not, 2) to explore how characteristics of the industry and of the R&D methods influenced the impact of public R&D. Thus, we purposively selected cases from

different industries, including oysters (two), wild prawns, farmed prawns and beef, and with different R&D research and dissemination methods used. In particular, the R&D methodology on supply chain analysis and dissemination was qualitative in the case of wild and farmed prawns and quantitative in the case of oysters and beef). Moreover, oyster farmers and wild prawn fishers had a much more centralized marketing strategy through their farmers' associations than beef and farmed prawn farmers. Centralization of marketing strategies seemed to be one of the emerging drivers of different R&D impact on famers' capabilities across industries.

Within each case, project stakeholders included CRC managers, project leaders (responsible both for research implementation and dissemination), industry representatives and a purposive selection of end-users, i.e. fishermen and farmers at grassroots level. The stakeholders were reached through a snowball approach—contacting the individuals named during the interviews by the respondents (Yin 2007). At this stage, we posed broad questions on stakeholders' perceptions and attitudes on the implementation and dissemination of the value chain project, their perspective of what should be consider a positive outcome of a value chain analysis R&D project, and their perceptions on which factors made the project successful or not (Dentoni and English 2012). From this first round of interviews, we understood that effective "learning-oriented activities" such as public R&D disseminating pre-competitive information about marketing and supply chain to farmers were perceived by project stakeholders as a form of success even when no financial impact were realized in the short run. Moreover, we inferred the impact of learning-oriented public R&D programs at CRC depended not only on industry characteristics and R&D methods used, but also on end users' characteristics including, among the others, their initial capabilities and their value discipline (Tracy and Wiersema 1993). This motivated the choice to proceed with a second more focused round of data collection.

In the second stage of data collection and analysis, the study was limited to only one public R&D program on marketing and supply chain to inductively explore which initial small farmers' characteristics influenced the public R&D impact on their market-sensing capabilities. The public R&D program analyzed is a value chain analysis co-funded by the Australian Seafood CRC and the Oyster Consortium (OC) and implemented by a consulting company in 2009- 2010. In this project, the principal investigator collected and analyzed market data in both qualitative (current demand trends, key issues as perceived by chain actors, relationships among supply chain partners) and quantitative form (estimation of profit margins and industry macro-trends) and disseminated results mainly though a detailed report that included the supply chain mapping and the estimated prices and quantities sold along the chain in different market channels. Dissemination of the results through the report and through shorter fact sheets took place also through numerous state association events (locally called "field days") taking place during 2010. Results of this public R&D program were also disseminated through CRC and OC websites and newsletters in the form of fact sheets with link to the full report.

In relation to the selected public R&D case in the Australian oyster sector, we undertook a survey with 34 growers whose characteristics are described in detail in Table 1. This stage of the research took place between May and December 2010. In particular, half of the selected sample (17) received the information from the Seafood CRC project and half that did not receive it. This created the variability to test the impact of the Seafood CRC information on growers' capabilities. Moreover, the selected sample was representative of the geographical distribution of

oyster growers in Australia, who are mainly focused in New South Wales and to minor extent in Victoria, South Australia and Queensland, and of size (Table 1). Contacts were obtained through complete lists of oyster growers in publicly available web lists. Farmers were contacted by email first and then, after receiving their consensus, called by phone. Among the oyster farmers contacted, twenty-one did not respond or declined the interview. A part of the oyster growers that declined the interviews mentioned that they had a negative past experience with public R&D programs, thus they did not want to collaborate with this survey. This may create a selection bias that inflates the positive impact of the public R&D on oyster growers'. In order to minimize the selection bias process, researchers used a "cheap talk technique" (Tonsor and Shupp 2012). The cheap talk was delivered both via email and on the phone. This cheap talk mentioned that the survey was a study conducted by academics independent from the public R&D agency and that results were used for evaluation purposes, therefore it was important to gain the perspective also of users that may have had negative experiences with the institution. Phone interviews lasted on average sixteen minutes.

Table 1. Description of sample of oyster growers interview

Oyster Farmers' Characteristics	**Description**
States	23 from New South Wales; 5 from Victoria; 4 from South Australia; 2 from Queensland.
Received the CRC project information	17 out of 34 (because of purposive sampling)
Time passed from receiving the CRC project information	Average: 11 months; Std. Dev.: 7 months.
General Wholesalers as customers	19 out of 34
Distributors as customers	4 out of 34
Food Service as customers	3 out of 34
Specialized Wholesalers as customers	5 out of 34
Retailers as customers	8 out of 34
Direct consumers as customers	5 out of 34

Combining Structural Equation Modeling with Qualitative Evidence

Through the interviews conducted with oyster farmers, researchers collected both quantitative and qualitative data to gain more insight on the cause-effect relationship among variables (Eisenhardt 1989). Quantitative data were analyzed with SEM (Hair et al. 2006, Kaplan 2009). First, SEM allows the researcher to combine measured variables and latent, complex concepts (Kaplan 2009) such as market sensing. Therefore, this multivariate statistic approach allows a rigorous analysis of the relationships between public R&D, dimensions of market sensing and identified conditions influencing R&D impact. Second, it provides the unique opportunity of building and testing frameworks representing complex webs of effects involving a chain of impacts relative to the project, the sector and the industry on firm's adoption of marketing research and ultimately on firm's innovation and performance. Finally, the open qualitative conversation had with the growers during the interviews allowed to make complete sense of the data, so that interpretation could be richer and more careful to the interviewees' perspectives

(Birkinshaw et al. 2011). Since the sample is very small relative to the number of relationships analyzed in the model, a bootstrapping technique of simulation (Kaplan 2009; Dentoni et al. 2012) was used to reach statistical power. Yet, the real sample (n=34) remains too small for hypothesis-testing, which is left to future research.

In the questionnaire, capability measures were adapted from the model used by Lindblom et al. (2008) which drew on Day's (1994) work about conceptualizing the market sensing abilities of firms. Lindblom et al. (2008) surveyed a number of retail entrepreneurs to test the effect of market sensing capabilities on the growth and profitability of the retailers. The questions were split into three sub constructs, namely sensing, sense making and response (Lindblom et al. 2008). These categories were then adapted to form our survey in conjunction with seeking feedback about the survey from seafood industry experts, the Seafood CRC management, utilizing our own new hypotheses and our observations from the face to face interviews that we had already conducted. The oyster project leader was also consulted and he modified and added questions to better focus the survey. The survey was split into four sections dealing with awareness of the oyster project, the search and use of information on customers and markets, relationships with customers, and understanding customers.

Section 1 of the questionnaire is meant to establish whether the respondent had received information on the public R&D program, the time of receipt of this information and the particular way it was received. This allows for analysis of the method and timing of dissemination of project outcomes and the most efficient or popular way to distribute the information. The second group of questions in section 1 is necessary in order to ascertain the extent or otherwise of use of the outcomes of the project. In order to determine whether or not firms are developing capabilities derived from the project outcomes it is necessary to identify what aspects of the project outcomes are most useful, if they were not useful, why not, and whether or not there has been a change to business practices from the project outcomes. Identifying whether a change has been made and what it is or if there is intention to make changes, and if there is some impediment to making those changes is also imperative. This will allow analysis of what specific aspects of the project are most useful for firms and whether other changes need to be made in the supply chain, regulations or operations of a particular industry in order to allow business to adapt and grow their capabilities.

Section 2 focused on the sub construct of 'sensing' as adapted by Lindblom et al. (2008) from Day's work (1994). In order to understand an industry's capability to sense the needs of their market the survey posed questions about what sources firms use to gather customer information, whether they exchange information with fellow growers to augment the information they find independently and how they evaluate the usefulness of this information. The final 4 questions in this section analyzed the degree to which the information that firms find about their markets and customers influence their business decisions. In business not all decisions are based on customers' needs, some decisions may be based on other drivers such as personal desires or the need to pay off debt. These questions were adapted from the 'sense-making' and 'response' sub construct as detailed by Lindblom et al. (2008).

Section 3 aimed to analyze the relationship growers have with their customers. Hooley et al (2005) identified that creating good customer relationships, loyalty and satisfaction helped to

build "superior market performance". The questions in this section were based on a list of marketing resources and performance items identified as key factors in building effective customer relationships (Hooley et al. 2005). The questions posed asked growers to rate their capability in building and maintaining good relationships in comparison to other growers and to clearly identify their main customers. This information helps to reinforce the results from the 'sense-making' section of the survey and determine the level of ability firms have in using the information in a profitable way to gain new customers, retain existing customers and build new relationships.

Section 4 drew on questions from both Hooley et al (2005) and some questions used to describe the norms operating in a selection of Japanese firms in an analysis of a variety of Japanese businesses as part of an organizational behavior study conducted by Deshpandé et al. (1993). The study posed questions about how well a firm knows their customers and if there is any procedure in place to measure or check that they their customers are happy and if they are using market and customer information effectively. In our survey we asked questions to determine how committed firms are to serving their customers, to what degree the firm's strategy is based on understanding customers and how firms go about increasing customer value if at all. Determining if there is a check system in place to understand and monitor customer satisfaction was also important to cross check against other sections of the survey and ascertain whether or not firms are actually sensing the market correctly and responding to that information in the most effective way.

In section 5 includes twelve questions assessing oyster growers' value discipline (Tracy and Wiersema 1993). We included variables on value discipline because the first round of data collection suggested that this oyster growers' characteristic may have an impact on their learning from public R&D. Value discipline refers to the competitive posture that a business organization chooses to deliver superior value to customers (Tracy and Wiersema 1993). Three value disciplines are identified: customer intimacy, product leadership and operational excellence. Firms competing on customer intimacy strive to develop products that tightly fit their customer needs. Firms competing on product leadership strive to continuously innovate on technology to provide superior tangible quality and convenience. Firms competing on operational excellence strive to improve efficiency of operations to keep low costs and prices (Tracy and Wiersema 1993). The three measures are in a trade-off among them, that is, respondents need to assign percentages to the three value disciplines for four questions. From the measures of value discipline, value discipline clarity is assessed (Micheels and Gow 2009). Firms that do not have a strong preference for one or two out of the three value disciplines have low value discipline clarity (Micheels and Gow 2009). Agri-food firms with low value discipline clarity have lower performance than companies with higher clarity (Micheels and Gow 2009). Finally, questions concluded with questions on the size of the firm in terms of number of employees and managers' past experience, age, gender and education (Damanpour 2006).

Key Selected Background

The Seafood CRC is a public-private R&D institution, which since 2007, undertakes and disseminates research on production, post-harvest and marketing issues throughout the seafood sector collaboratively with research institutions and industry organizations. This is one of the many Cooperative Research Centres instituted by the Australian Government since 1991 to

enhance collaboration between researchers and private actors in both agricultural and non-agricultural sector. It involves a seven-year plan of investment equal to Australian $140 million from 2007 to 2013. Out of this amount, $77 million is cash from the Commonwealth Government, the Fisheries and Research Development Corporation and the seafood industry, and in minor part from the South Australian Government and other research and development providers.

Three major R&D programs characterize the Seafood CRC: production innovation, innovation in post-harvest technologies and marketing, and education. Specifically, the Seafood CRC program on innovation in post-harvest technologies and marketing included more than seventy projects which are completed, being undertaken or just started. Overall, this program aims at improving profit margins of the primary seafood industry by 1) providing knowledge and expertise for the industry to seize profitable market opportunities and by 2) providing innovation concepts in post-harvest technology for the industry to optimize their operations (i.e. to reduce spoilage and losses). In particular, a set of projects in the Seafood CRC program on innovation in post-harvest technologies and marketing has the more specific aim of transferring knowledge and capabilities to the industry for expanding their vision and search of market opportunities. This set included among the others projects with the Australian oyster grower and farmed prawn industry, the Spencer Gulf wild prawn fishery in South Australia and the finfish industry in Western Australia.

The project with the oyster industry was based on a partnership between the Seafood CRC, the Oyster Consortium and an external consulting company as research provider. The research was conducted in 2008 and disseminated to the Oyster Consortium and oyster growers between 2009 and 2010. The project was designed as a broad information gathering exercise with no pre-defined commercial outcome. The project aimed to deliver information to oyster growers and the Oyster Consortium to achieve a better understanding of the supply chain from farm gate to the consumer's plate. The project had five main objectives: to map the entire supply chain and provide approximate numbers of oysters moving along each section of the chain; to calculate the volume, location and production for each species of oyster; to elicit and discuss drivers of oyster demand; to calculate the various transaction costs to ascertain where and to whom the profits are going and provide recommendations to help ensure the long term sustainability of the oyster industry. The study was conducted by performing a detailed analysis of eight market channels tracking the oysters from the grower to the final stage of consumption by the consumer. This was conducted through research, observation of the chain and interviews with various players along the chain. This research resulted in a detailed supply chain analysis detailing each step in the chain. A detailed financial breakdown was also provided showing the margins along each step in the supply chain. Some of the retail margins were approximate due to commercial sensitivities from some players not wanting to reveal actual costs. Once the data collection and analysis was completed, the information was disseminated in a variety of ways including newsletters and hard copies of the report but mainly thorough presentations by the research provider at field days, Oyster Consortium meetings and state oyster association meetings. The Seafood CRC projects with the farmed prawn and finfish industry had the same approach of research and dissemination.

The project with the Spencer Gulf wild prawn industry was based on a partnership among the Seafood CRC, Spencer Gulf Wild Prawn Fishermen Association (SGWPFA) and a consultant at

the Department of Primary Industries and Resources of South Australia (PIRSA). The project was conducted in late 2009 and the information was presented to the SGWPFA, the fisherman and the partners in the prawn value chain through meetings and distribution of the final report. The main objective of the project was to screen and analyze market opportunities which could derive greater profit from the fishery. This involved a detailed value chain analysis and close collaboration with various members of the value chain. The license holders involved in the fishery involved were thirty-seven, six of the key portside buyers, as well as local retailer and restaurant managers. In this case, a rapid appraisal of the chain was performed to identify the partners along the chain and the expectations and requirements on prawn supply. This research also used secondary data from consumer research on prawns along with interviews with chain members. It followed analysis of interview results, which involved mapping the product flow and information flow and establishing the strength of relationships along the chain. Finally, results from this analysis were disseminated to the industry with meetings to the group of prawn licence-holders and individual meetings with buyers, processors, retailers and restaurants.

Both of these two R&D project methodologies involved detailed analysis of the supply chain in each of the fisheries. Similarly both involved interviews and detailed analysis of the each step in the chain through close collaboration with chain members, research providers and the growers or fishermen themselves. In both cases a large amount of information about the chain has been provided back to the relevant industry associations, growers and fishermen with suggestions to make strategic and operational changes or adjustments to how their businesses or industries are operated. The main difference between the projects is that the oyster project was focused on providing information to the growers and industry whereas the prawn value chain project has a specific commercially-based outcome to expand specific market opportunities to increase the value of the fishery. This might include utilizing a new brand emphasizing the local and sustainability attributes of prawns, changing the marketing strategy by switching to a single desk joint selling point or introducing new post-harvest technological innovations.

Results of the Survey with Oyster Farmers

Results from the structural equation models (Table 2, see Appendix) and related qualitative data analysis can be synthesized as follows:

1. The value chain information disseminated by the CRC project had a positive impact on farmers' market sensing capabilities (Table 3). In particular, the project information had an impact on farmers' capability of searching information (F1) and processing information (F2). The causality between information from the project and market sensing capabilities is confirmed by the qualitative evidence collected in the semi-structured interview. Around 80% of the farmers receiving the project information mentioned that - before receiving project information - they were unaware of 1) the number of actors downstream the oyster value chain between their customer and the final consumer and 2) of the margins made by each actor within the chain, and particularly by their customers.

2. Farmers that have learned most from the project (BLearning) are the ones that had lower capabilities of searching market information (F1). These are mainly the farmers that showed higher surprise on information about margin and value chain structure. Around

40% of farmers mentioned that, if they knew this information earlier, they would 1) have attempted to take different market strategies in the recent past and 2) they would have exercised less pressure on their customers and built a more trust-based relationship. Instead, the segment of farmers with highest market sensing capabilities did not really get a marginal increase in learning from receiving this information. As many farmers in this segment stated, the information from the value chain analysis mostly confirmed knowledge that they already had.

3. Farmers' capability of searching (F1), processing (F2) and using market information (F3) are strongly correlated among each other. This confirms that these three subsequent activities can be effectively synthesized by the concept of market sensing. Moreover, market sensing is positively associated with building stronger ties with customers (F4). In 10 interviews, farmers with high market sensing capabilities demonstrated that they used the new information not only to evaluate their current market strategy but also to re-assess the strategic intent of the on-going public-private R&D projects. In particular, farmer mentioned: 1) the importance of keeping strong relationships with existing customers and collectively promote the healthy properties of the product; 2) the scarce relevance of shifting market channels towards supermarkets; 3) the importance of creating new occasions of use of the oyster product and facilitate the access and disposal to the product, especially for new consumers.

4. Results on oyster growers' value discipline (Figure 1) show that the majority of growers create value by attempting to anticipate and serve customer needs and by innovating to have the up-to-date product for quality. Out of the 34 sampled, 19 growers have a value discipline that is close to the customer intimacy/ product leader ship line (Figure 1). Seven of them are very close to the "customer leadership" corner. A smaller amount of growers create value by serving customer needs while focusing on operational efficiency. Out of the 34 sampled, six growers are close to the customer intimacy/ product leadership line.

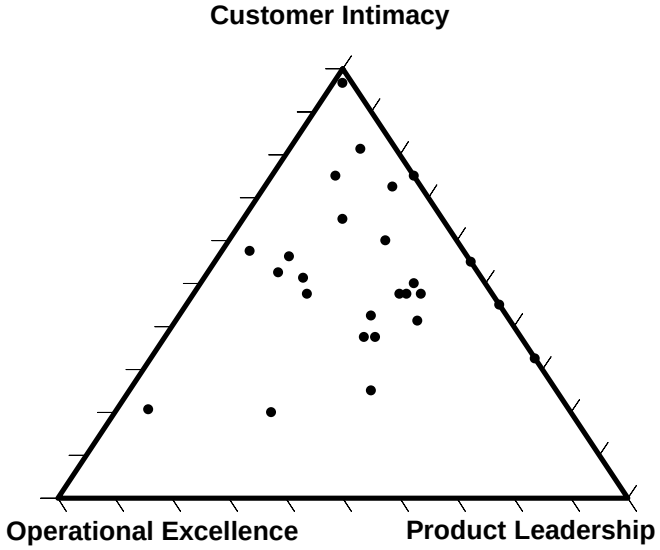

Figure 1. Sampled Oyster Farmers' Value Discipline and Value Discipline Clarity

Legend. Each dot represents a graphical representation of the value discipline of one oyster farmer sampled. The ternary plot was created using an Excel program developed by Graham and Midgley (2000). Value discipline clarity is calculated as the minimum distance from coordinate to a boundary of the triangle through a half-taxi metric (Miller 2002).

5. Farmers' value discipline clarity is strongly associated with their market sensing capabilities. In particular, farmers with the highest levels of value discipline clarity are the most able to search for market information and, consistently with point 2 above, have learned fewer new information from the dissemination of project results.

6. Demographic factors seldom play a role in the impact of project information on farmers' market sensing capabilities. In particular:

7. Project information has been received mainly by younger farmers with less years of experience in the oyster sector. Although younger, open interviews revealed that many of them have already a central role in the oyster growers' networks within their state and national associations.

8. Elder farmers have a relatively higher capability in processing market information and customer advantage, while farmers that had previous job before growing oysters have a capability advantage in searching market information.

9. The rejection of the other models based on the overall goodness-of-fit indexes (Table 1) implies that:

10. After an average of eight months after receiving the project information, no significant impact on changes in farmers' marketing activity took place. Most of the farmers (14 out of 17 receiving the project information) mentioned that value chain information from the project was useful learning to future negotiations with existing customers and to explore future opportunities, but they do not intend to make market changes in the short run. Moreover, 50% of the farmers mentioned that, although they would like to make changes, financial and/or volume of supply constraints do not allow them to innovate. Only three farmers out of 17 mentioned that they already made changes in their product development and customer channels after receiving the project (on average, these three received the information more than one year after the time of the interview).

11. The impact of the disseminated value chain information does not have an impact on farmers' customer-linking capabilities, but only on market sensing capabilities.

12. The impact of the disseminated value chain information on market sensing capabilities does not depend on what the existing customer channels (general or specialized wholesalers, fishmongers, direct to consumers, food service or retail) that the farmers had.

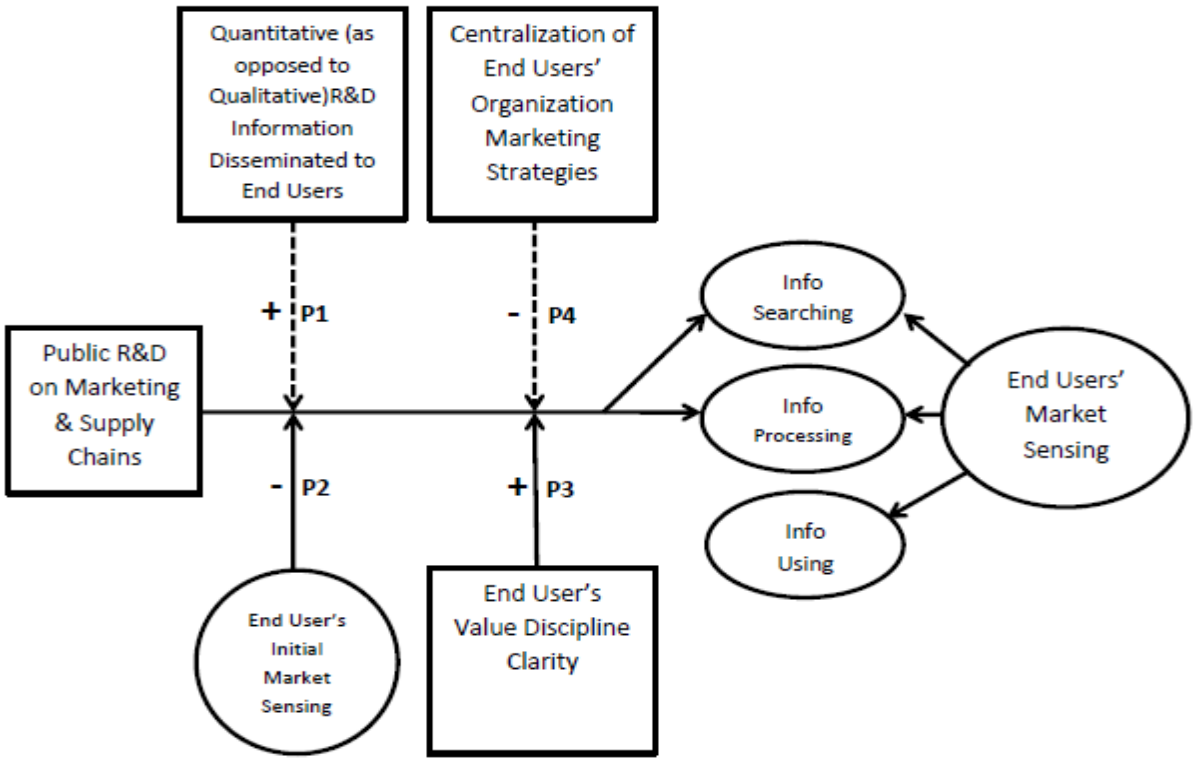

Figure 2. The Proposed Framework: The Impact of Public R&D on Marketing and Supply Chain on End Users' Market-Sensing Capability

Legend. Each arrow represents a causal relationship between two concepts (represented by boxes), either positive (+) or negative (-). P1, P2, P3, P4 refer to the propositions stated in Section 6. Dotted arrows represent propositions established based on qualitative evidence through comparison across cases. Full arrows represent propositions based on quantitative evidence through SEM within the "typical" oyster case.

Discussion and Research Implications

Impact of Public R&D on Small Farmers' Market Sensing

Results from the cross-comparison of five value chain projects and the in-depth analysis of the oyster sector provide evidence supporting the following set of propositions on the impact of public R&D value chain information on farmers' market sensing capabilities.

First, chain actors systematically found that the quantitative information from the R&D value chain projects was more useful than qualitative information about the structure and the relationships along the supply chain. Out of 17 sampled, 15 oyster farmers mentioned that information on estimated chain partners' margins was the key information from the R&D project report. This is information immediately gave respondents knowledge on the magnitude of the market opportunities that were in place for them if they had upgraded their services and supply to current customers or if they had switched to a different customer or channel. Based on

information on estimated margins, respondents could begin comparing potential benefits and costs of taking individual actions on marketing and supply chain. Similarly, chain actors in the beef and farmed prawn receiving quantitative information from the chain analysis found the information useful, as opposed to the chain actors in the beef and wild prawn sectors that received only qualitative information. This evidence leads to the following propositions:

> *P1. Research methods involving a quantitative estimation of chain players' profit margins have a positive role on the relationship between R&D projects and targeted firms' market-sensing capabilities.*

Second, data from the 34 oyster growers sampled revealed that value discipline clarity and initial lower levels of market-sensing made end users' learning from public R&D on marketing and supply chain more effective (Table 2 and 3, see Appendix). Therefore, the two propositions follow:

> *P2. The lower the initial levels of end users' market sensing, the higher the impact of public R&D on marketing and supply chains on their market-sensing capabilities.*
> *P3. The higher the end users' value discipline clarity, the higher the impact of public R&D on marketing and supply chains on their market-sensing capabilities***.**

Qualitative data from the cross-comparison of five value chain projects and the in-depth analysis of the oyster sector provided evidence on the relationship between end users' capabilities and their industry association capabilities. In particular, the level of centralization of the decision-making within the industry association partnering within the R&D project influences the extent of capability transfer to the grassroots levels of the organization and therefore to the individual end users. In the Australian seafood industry, associations that take highly centralized strategic decisions about markets, with fishermen and growers remaining mainly focused on their daily operations. This is the case of local oyster associations and wild prawn associations. In these cases, individual end users learned less extensively from public R&D projects than in cases of large, decentralized associations. Conversely, national industry associations often have a de-centralized structure, such that R&D project information flows from the center to the periphery with a larger number of industry members accessing and elaborating it. Therefore a higher number of individual end users learn more from public R&D value chain project results when the project is delivered to national-level industry associations with a de-centralized structure. Therefore, the following final hypothesis is stated:

> *P4. The level of industry association's centralization of strategic decision-making has a negative moderating role on the relationship between R&D projects and targeted firms' market-sensing capabilities.*

These seven propositions compose the theoretical framework described in Figure 2, which can be tested in future research based on the empirical evidence so far collected.

Conclusions

Developing "double-loop learning" (Argyris 1977) is instrumental to ensure sustainability of public R&D project outcomes. This applies also to public R&D on marketing and supply chains in the agri-food sector, where the policy objective justifying the public R&D investment is two-fold: 1) providing valuable pre-competitive information to allow farmers making market–driven innovations; 2) developing farmers' market-sensing capabilities, which is a key driver of market orientation, innovation and entrepreneurship (Day 1994; Micheels and Gow 2008). Based on the evidence from five cases of public R&D in the seafood sector and from an-depth "typical" case of public R&D in the oyster sector, this study explored under which conditions public R&D on marketing and supply chains has an impact on the market-sensing capabilities of small farmers. A grounded theory approach of inductive research (Eisenhardt 1989) based on mixed qualitative and quantitative data collection and analysis (Birkinshaw et al. 2011) was applied to discern the impact of public R&D on small farmers' accessing market information from the impact on their double-loop learning, that is, their ability of searching, processing and learning market information in the future.

Empirical evidence from the Australian Seafood CRC cases revealed that that receiving quantitative information on profit margins and quantity flows along the chain is an essential information for the development of market-sensing capabilities. Moreover, small farmers with initial lower levels of market sensing capabilities and high value discipline clarity are the ones learning most from the public R&D dissemination process. Finally,; public R&D has stronger impact on small farmers' capabilities when the industry association is also market oriented and when it decentralizes marketing decisions to the individual member firms.

In this research, an inductive "grounded theory" approach which is exploratory in nature is used to gain knowledge in an area where there is no previous research done, that is, when public R&D has an impact end users' market sensing capabilities in the agri-food sector. This theory-building study led to the development of propositions to be tested in future research. In particular, research would benefit from expanding the quantitative data collection to a set of purposive public R&D cases selected based on the structure of the inter-organizational industry associations which public R&D end users belong to and the characteristics of the public R&D research and dissemination methods. Finally, collecting baseline data on the initial farmers' market sensing capabilities into a panel database would effectively test the change in market sensing capability over time due to public R&D. This would also provide a test for the causal relationship between public R&D and development of market-sensing capabilities, which in this study is proposed based on qualitative discussions with the interviewees.

References

Allen, P. 1999. Reweaving the food security safety net: Mediating entitlement and entrepreneurship. *Agriculture and Human Values* 16(2): 117-129.

Andersen, M. A. and W. Song. 2013. The Economic impact of public agricultural research and development in the United States. *Agricultural Economics* 44 (3): 287-295.

Anderson, J. and J. Narus. 2007. *Business market management. Understanding, creating and delivering value.* Prentice Hall: New York.

Argyris, C. 1997. Double Loop Learning in Organizations. *Harvard Business Review* 55: 115-125.

Beverland, M. and A. Lindgreen. 2007. Implementing market orientation in industrial firms: A multiple case study. *Industrial Marketing Management* 36 (4): 430–442.

Birkinshaw, J., M. Y. Brannen and R. L. Tung. 2011. From A Distance And Generalizable To Up Close And Grounded: Reclaiming A Place For Qualitative Methods. An International Business Research. *Journal of International Business Studies* 42 (5): 573-581.

Capitanio, F., A. Coppola and S. Pascucci. 2009. Indications for Drivers of Innovation in the Food Sector. *British Food Journal* 111 (8): 820-838.

Clarysse, B., M. Wright and P. Mustar. 2009. Behavioural additionality of R&D subsidies: A learning perspective. *Research Policy* 38(10): 1517-1533.

Cohen, W. M., and D. A. Levinthal. 1990. Absorptive capacity: a new perspective on learning and innovation. *Administrative science quarterly* 35 (1): 128-152.

Damanpour, F. 1996. Organizational Complexity and Innovation: Developing and Testing Multiple Contingency Models. *Management Science* 42: 693-716.

Day, G.S. 1994. The Capabilities of Market-Driven Organization. *Journal of Marketing* 58 (4): 37-52.

Dentoni, D. and F. English. 2012. Dealing with Cultural Differences in Public-Private R&D Projects: The Experience of the Australian Seafood Sector. *International Food and Agribusiness Management Review* 15(A): 131-136.

Dentoni, D., D. Menozzi and M. G. Capelli. 2012. Group heterogeneity and cooperation on the geographical indication regulation: The case of the "Prosciutto di Parma" Consortium. *Food Policy* 37(3): 207-216.

Dentoni, D. and T. Reardon. 2010. Small farms building global brands through social networks. *Journal on Chain and Network Science* 10(3): 159-171.

Deshpandé R., J.U. Farley and F.E. Webster. 1993. Corporate Culture, Customer Orientation, and Innovativeness in Japanese Firms: A Quadrad Analysis. *Journal of Marketing* 57: 23-27.

Eisenhardt, K.M. 1989. Building Theories from Case Study Research. *Academy of Management Review* 14: 532-550.

Falk, R. 2007. Measuring the effects of public support schemes on firms' innovation activities: Survey evidence from Austria. Research Policy 36(5): 665-679.

Graham, D.J., and N. G. Midgley. 2000. Graphical Representation of Particle Shape Using Triangular Diagrams: An EXCEL Spreadsheet Method. *Earth Surface. Processes and Landforms* 25 (13): 1473–1477.

Glaser, B.G. and A.L. Strauss. 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research.* London, Wiedenfeld and Nicholson.

Grunert, K. 2005. Food quality and safety: consumer perception and demand. *European Review of Agricultural Economics* 32 (3): 369-391.

Hair, J.F., W. C. Black, B. J. Babin, R. E. Anderson and R.L. Tatham. 2006. *Multivariate Data Analysis*, Upper Saddle River, NJ: Pearson Prentice Hall.

Holster, H., L. Klerkx and B. Elzen. 2008. Stimulating entrepreneurship: The impact of a new way of organizing dairy farmers. *8th European IFSA Symposium*.

Hooley, G.J., G. E. Greenley, J. W. Cadogan and J. Fahy. 2005. The performance of marketing resources. *Journal of Business Research* 58: 18-27.

Hsu, F.M., D. J. Horng and C. C. Hsueh. 2009. The effect of government-sponsored R&D programmes on additionality in recipient firms in Taiwan. *Technovation* 29(3): 204-217.

Kaplan, D. 2009. *Structural Equation Modelling: Foundations and Extensions*. Thousand Oaks, CA: Sage Publications, Inc.

Klerkx, L., N. Aarts and C. Leeuwis. 2010. Adaptive Management in Agricultural Innovation Systems: The Interactions Between Innovation Networks and Their Environment. *Agricultural Systems* 103(6): 390-400.

Knockaert, M., A. Spithoven. and B. Clarysse. 2014. The impact of technology intermediaries on firm cognitive capacity additionality. *Technological Forecasting and Social Change* 81: 376–387.

Knudson, W., A. Wysocki, J. Champagne. and H.C. Peterson. 2004. Entrepreneurship and Innovation in the Agri-Food System. *American Journal of Agricultural Economics* 86 (5): 1330-1336.

Kohli, A.K and A.K. Jaworski. 1990. Market Orientation: Antecedents and Consequences. *Journal of Marketing* 57: 53-70.

Lankinnen, J., M. Rokman, and P. Tuominen. 2007. Market-sensing capability and market orientation in the food industry: empirical evidence from Finland. *19th Nordic Academy of Management Conference*.

Lindblom, A.T., R.M. Olkkonen, L. Mitronen and S. Kajalo. 2008. Market Sensing Capability and Business Performance of Retail Entrepreneurs. *Contemporary Management Research* 4 (3): 219-236.

Link, A.N. and J. T. Scott. 2013. Public R&D subsidies, outside private support, and employment growth. *Economics of Innovation and New Technology* 22 (6): 537-550.

Martin, J.H., B. A. Martin and P. R. Minnillo. 2009. Implementing a market orientation in small manufacturing firms: From cognitive model to action. *Journal of Small Business Management* 47: 92-115.

Micheels, E.T. and H.R. Gow, 2008. Market orientation, innovation and entrepreneurship: an empirical examination of the Illinois beef industry. *International Food and Agribusiness Management Review* 11 (3): 31-56.

Micheels, E.T. and H.R. Gow. 2009. Do Market Oriented Firms Demonstrate Clarity on Their Value Discipline: Evidence from Illinois Beef Producers. *International Food and Agribusiness Management Review* 13 (3): 127-152.

Miller, W.E. 2002. Revisiting the Geometry of a Ternary Diagram with the Half-Taxi Metric. *Mathematical Geography* 34 (3): 275-290.

Olavarrieta, S. and R. Friedmann 2008. Market orientation, knowledge related resources and firm performance. *Journal of Business Research* 61: 623-630.

Pardey, P.G., J. M. Alston and C. Chan-Kang. 2013. Public agricultural R&D over the past half century: An emerging new world order. *Agricultural Economics* 44 (1): 103-113.

Rapp, A., K. J. Trainor and R. Agnihotri. 2010. Performance implications of customer-linking capabilities: Examining the complementary role of customer orientation and CRM technology. *Journal of Business Research* 63 (11): 1229-1236.

Sankaran, J.K. and V. S. Mouly. 2006. Value-Chain Innovation in Aquaculture: Insights from a New Zealand Case study. *R&D Management* 36 (4): 367-466.

Teece, D.J., G. Pisano and A. Shuen. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal* 18(7): 509-533.

Tonsor, G. T. and R. Shupp. 2011. Cheap Talk Scripts and Online Choice Experiments: Looking Beyond the Mean. *American Journal of Agricultural Economics* 93(4): 1015-1031.

Treacy, M. and F. Wiersema. 1993. Customer Intimacy and other Value Disciplines. *Harvard Business Review* 71 (1): 84-93.

Verhees, F.J.H.M. 2005. Market-oriented product innovation in small firms. PhD-thesis, Wageningen University, The Netherlands.

Vogels, B. 2008. Innovativeness in fruit producing and fruit processing chains. MSc Thesis, Wageningen University, The Netherlands.

Wanzenböck, I., T. Scherngell and M. M. Fischer. 2012. How do firm characteristics affect behavioural additionalities of public R&D subsidies? Evidence for the Austrian transport sector. *Technovation* 33 (2-3): 66–77

Yin, R.K. 2009. *Case Study Research: Design and Methods.* Newbury Park, Sage Publications.

Appendix

Table 2. Goodness of Fit Comparison across Competing Models

Satorra-Bentler Goodness of Fit Measures	**Model 1 n=34**	**Model 2 n=34**	**Model 3 n=34**	**Model 4 n=34**	**Model 5 n=34**	**Model 6 n=34 Bootstrap**
X^2; d.f.	35.69; 66	51.23, 78	95.01, 136	105.7, 98	145.35, 96	137.82, 136
X^2 p-value	0.58	0.31	0.45	0.28	0.00	0.00
RMSEA	0.000	0.052	0.018	0.049	0.125	0.2279
RMSEA l.b.	0.000	0.000	0.000	0.000	0.080	0.1790
RMSEA u.b.	0.110	0.127	0.094	0.105	0.162	0.2701
CFI	1.000	0.986	0.997	0.977	0.870	0.723
AIC	-40.3	-42.76	-92.99	-90.30	-46.65	88.96

Legend. Model 1 = Impact of public R&D (=INFOCRC in Table 3 and 4) on market sensing .
Model 2 = Impact of public R&D on market sensing, controlling for farmers' belief of learning.
Model 3 = Impact of public R&D on market sensing, controlling for farmers' belief of learning and demographics (Results presented in Table 3a)
Model 4 = Impact of public R&D on market sensing, controlling for farmers' belief of learning, demographics and value discipline clarity (Results presented in Table 3b)
Model 5 = Impact of public R&D on market sensing, controlling for farmers' market strategy change and demographics.
Model 6 = Impact of public R&D on market sensing, controlling for farmers' belief of learning and demographics (Model 3 after bootstrapping with 35 repetitions).

Table 3a. The Impact of Public R&D on End Users' Market-Sensing Capabilities

Dependent Variable	Independent Variable	Standardized Path Estimates	t-test
Age	Male	-0.53	3.06
	Error	*0.85*	
Experience	Age	0.46	2.97
	Previous Job	-0.39	2.67
	Error	*0.80*	
INFOCRC	Age	-0.25	-1.46
	Experience	-0.37*	-2.18
	Error	*0.85*	
BLearning	Age	-0.23	1.39
	Previous Job	-0.21	1.23
	Error	*0.95*	
IS1	Info Searching (F1)	0.60*	2.51
	Error	*0.80*	
IS2	Info Searching (F1)	0.63*	3.03
	Error	*0.78*	
IS3	BLearning	0.33	1.71
	Info Searching (F1)	0.72*	4.14
	Error	*0.74*	
IP1	Age	0.18*	1.99
	Info Processing (F2)	0.95*	3.84
	Error	*0.41*	
IP2	Info Processing (F2)	1.30*	8.21
	INFOCRC	-0.40*	2.90
	Previous Job	0.17	1.06
	Error	*0.00*	
IP3	Info Processing (F2)	0.88*	3.91
	BLearning	0.33*	2.18
	Male	-0.17	1.37
	Error	*0.50*	
IU1	Info Using (F3)	0.89*	9.60
	INFOCRC	0.14	1.50
	Error	*0.26*	
IU2	Info Using (F3)	0.96*	10.90
	Error	*0.27*	
CA1	Customer Advantage (F4)	0.94*	8.82
	Error	*0.34*	
CA2	Customer Advantage (F4)	0.93*	8.89
	INFOCRC	0.33*	4.40
	Error	*0.26*	
CA3	Customer Advantage (F4)	0.68*	5.47
	INFOCRC	0.21	1.26
	Age	0.26*	1.95
	Error	*0.62*	
F1	INFOCRC	0.38*	1.82
	BLearning	-0.30	-1.18
	Male	0.22	0.82
	Previous Job	0.49*	1.83
	Error	*0.59*	
F2	INFOCRC	0.31	1.25
	Experience	-0.13	-1.32
	F1	0.62*	2.00
	Error	*0.47*	
F3	F2	0.75*	3.28
	Error	*0.66*	
F4	F2	-0.10	-0.66
	Error	*0.99*	

Goodness to Fit Indices: Satorra-Bentler scaled $\chi 2$= 95.01 on 136 d.f.; P-value for $\chi 2$ = 0.45 CFI = 0.997; RMSEA = 0.018; RMSEA 90% Confidence Interval = (0.000, 0.094). Note. Asterisk (*) denotes variables significant at 5%.

Table 3b. The Impact of Public R&D on End Users' Market-Sensing Capabilities, Controlling for Farmers' Value Discipline Clarity

Dependent Variable	Independent Variable	Standardized Path Estimates	t-test
Value Discipline	Age	-0.37*	2.35
Clarity	Previous Job	0.25	1.46
Age	Male	-0.53*	3.55
Experience	Age	0.46*	3.27
	Previous Job	-0.39*	2.67
INFOCRC	Age	-0.25	1.39
	Experience	-0.37*	1.96
BLearning	Age	-0.41*	2.11
	Value Discipline Clarity	-0.50*	2.07
IS1	Info Searching (F1)	-0.52*	2.27
	Male	-0.37*	1.78
IS2	Info Searching (F1)	-0.38	1.38
	Previous Job	0.19	1.57
	Male	0.35	1.30
IS3	BLearning	0.23	0.19
	Info Searching (F1)	0.39	0.21
	Male	0.16	0.47
	Previous Job	0.39	1.02
IP1	Age	0.17*	2.22
	Info Processing (F2)	0.93	1.82
IP2	Info Processing (F2)	-0.36*	2.16
	INFOCRC	1.26*	2.09
	Previous Job	0.14	1.34
IP3	Info Process (F2)	0.33	1.79
	BLearning	-0.86*	2.21
	Male	-0.23*	2.19
IU1	Info Using (F3)	0.87	1.63
	INFOCRC	0.15*	8.98
IU2	Info Using (F3)	0.97*	11.35
CA1	Customer Advantage (F4)	-0.97*	9.26
CA2	Customer Advantage (F4)	-0.95*	7.15
	INFOCRC	0.35*	4.44
CA3	Customer Advantage (F4)	-0.30*	4.48
	INFOCRC	0.23	1.47
	Age	0.34*	2.28
	Male	-0.54	1.13
	IS2	0.30*	2.25
F1	INFOCRC	-0.66*	2.50
	BLearning	0.39*	2.15
	Value Discipline Clarity	0.48*	1.98
	Previous Job	0.25	1.20
F2	Value Discipline Clarity	-0.20	0.63
	Experience	0.23	1.67
	F1	0.63	1.52
F3	F2	0.74	.59
	Value Discipline Clarity	0.96	1.75
F4	BLearning	0.34	1.10
	Value Discipline Clarity	0.36	1.40
	F2	0.27	0.95
	Previous Job	-0.26	1.17

Goodness to Fit Indices: Satorra-Bentler scaled χ^2= 105.70 on 153 d.f.; P-value for χ^2 = 0.28 CFI = 0.977; RMSEA = 0.049; RMSEA 90% Confidence Interval = (0.000, 0.105). **Note.** Asterisk (*) denotes variables significant at 5%. **Legend:** *INFOCRC* = public R&D information; *BLearning* = end users' perception of learning from R&D information; IS1, IS2, IS3: items on information searching (F1); IP1, IP2, IP3: items on information processing (F2); IU1, IU2: items on information searching (F3); CA1, CA2, CA3: items on customer advantage (F4).

