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Measuring innovation capacity: From single companies to value chains

Bert Vermeire, Bianka Kühne*, Virginie Lefebvre and Xavier Gellynck

Ghent University
Department Agricultural Economics
Coupure Links 653, B-9000 Gent,

*corresponding author: Bianka.Kuhne@Ugent.be

Abstract
In order to respond to a number of problems related to the measurement of innovation, we propose an approach for innovation measurement which responds to these problems. Our approach will focus on the agrifood sector, due to the specific characteristics and problems related to innovation in this sector. First we develop a concept of innovation taking into account its multiform, complex and embedded character. Then we prove our concept by applying it to the sector of traditional food products. We can show that our concept of innovation is working well in a value chain frame. This paper has important implications for further research. For future research we suggest, to prove its generalizability to other sectors.

Keywords: Concept of innovation capacity, SMEs, agrifood sector

1. Introduction

During the last decades, the concept of innovation has gained tremendous popularity in the discourse of economists, business communities and policy makers. Despite the widespread agreement that innovation is a precondition for competitive and sustainable economies, there is little consensus about the definition of innovation. This is strongly related to the complex nature of innovation process (Gellynck *et al.*, in press).

A number of theoretical insights can be identified which have elucidated the concept of innovation, on the one hand, but which have increasingly extended the breadth and depth of the concept, making it more difficult to apply, on the other.
First, the conception of innovation as a simple linear and basically research driven process has been abandoned because of the recognition that innovations are not always research driven, but generated by interactions among different actors and knowledge flows. Innovation development is no longer seen as a linear process, but as a complex process involving false starts, returns between stages, dead ends, trials and errors (Rothwell, 1992; Tidd *et al.*, 2005; Balconi *et al.*, 2008; Kirner *et al.*, 2009).
Second, the contribution of innovation to economic growth is not only due to radical, breakthrough innovations but also to incremental changes which take place over time (Dewar and Dutton, 1986; Lettl *et al.*, 2006). Further, incremental changes might have breakthrough effects e.g. a small change in the distribution of manufactured products leading to tremendous cost-reduction (Omta 2002: Antonelli, 2006).
Third, innovation can be situated at the level of the product, but also at the level of production processes, organizational changes and marketing strategies (Lundvall 1995; Fischer 2001; Becheikh, Landry et al. 2006).
Fourth, the view on how innovation is driven has changed over time from a supply-push to a demand-pull innovation. Thereby, demand-pull innovation, also called user-oriented innovation, is the effort of all actors involved in the innovation process to maximize the value creation towards the final consumers and rapidly respond to their new demands *(Grunert et al.*, 2008; Weaver 2008).
Fifth and finally, innovation always involves dilemmas, whereby the entrepreneur faces the complex task to take a management decision under uncertainty about market demand, industry response (e.g. pricing policy, product imitation) and also production and development costs (Dawid *et al.*, 2001, Miller, 2008). In some cases, not innovating may be the best management decision. This confronts researchers with a fundamental dilemma: to narrow down the focus to a specific aspect of innovation or to apply a rather holistic approach in order to obtain an overall understanding.

The change from supply-push towards demand-pull innovation has been proven to be very important in particular for the agrifood industry, because of the increasing number of intangible components involved in the innovation process, the fast changes in consumer needs, and the growing demand for more sustainable production (Grunert *et al.*, 2008). Further, the fundamental environmental changes of the last century, including the fast development in information and communication technology and internationalization affected all areas related to food production (Avermaete and Viaene, 2002; OECD, 2005). In response, the agrifood industry developed strategies that are not based on R&D but include a learning process and interaction between different actors. Thus, the locus of innovation has changed from the single enterprise to more and more the value chain (Powell *et al.*, 1996; Omta, 2002; Omta, 2004; Pittaway *et al.*, 2004; Grunert *et al.*, 2008). This prompts the need to develop measures to evaluate innovation both at the company and value chain level. Former studies have shown that companies in the agrifood sector are highly dependent on external sources of information for innovation and hence have to open up their innovation process to their value chain (Stewart-Knox and Mitchell, 2003; Avermaete *et al.*, 2004; Enzing *et al.*, 2008; Sarkar and Costa, 2008).

A value chain consists of three members: the food manufacturer (FM), the supplier of the FM and the customer of the FM, which is also called the direct chain (Mentzer *et al.*, 2001). These value chain members are involved in the upstream and downstream flows of products, services, finances and information in a vertical structure (Mentzer *et al.*, 2001; Van der Vorst, 2000).In our paper innovation is defined as an ongoing process of learning, searching and exploring, resulting in new products, new techniques, new forms of organization and new markets (Lundvall, 1995) which are new to the enterprise and to the industry ranging from incremental to radical innovations. Consequently, we are broadening the focus from the commonly investigated product and process innovations to the less acknowledged market and organisational innovations. The first seem to be good indicators for innovation in R&D-intensive and high-tech industries. However, in low-tech industries there is also considerable innovation occurring from other than high R&D activities, as is often the case in small and medium sized enterprises (SMEs)[1] the agrifood sector is mainly composed of (Lagnevik *et al.*, 2004; Gellynck *et al.*, 2007; CIAA, 2008; Kirner *et al.*,2009).

Furthermore, for the measurement of innovation in SMEs it is less suitable to use indicators such as the number of patents, number of employees involved in R&D, or counts of incremental and radical innovations (Avermaete and Viaene, 2002; Maravelakis *et al.*, 2006). In particular for SMEs in the agrifood sector, which is a sector of mainly low-tech industries where innovations seldom draw on R&D activities, other indicators for measuring innovation must be applied such as structured and non-structured efforts, new or improved products, processes, markets and organisational developments, as well as the contribution of these innovation activities to the business success (Gellynck *et al.*, 2007). However, there is no consistent use of the indicators in the literature. Some indicators for measuring innovation are also used to measure other concepts, such as absorptive capacity, R&D performance and technology level.

Further, innovation is measured in different ways and under different names e.g. innovation generation (Roy *et al.*, 2004), innovation competence (Gellynck *et al.*, 2007) innovative capability (Petroni and Panciroli, 2002), continuous innovation (Soosay *et al.*, 2008), innovation capability (Tuominen and Hyvönen, 2003), successful innovations (Omta, 2002; Pannekoek *et al.*, 2005) and autonomous and system innovation (Bröring, 2008). Nevertheless, all approaches measure innovation items internal and external to the enterprise. Internal items relate to company characteristics, whereas external items refer to interactions and interdependences with the enterprise’s environment.

However, only few of these studies focus in particular, but not exclusively, on the innovativeness of SMEs. Moreover, in most of these studies the unit of data collection is one focal enterprise rather than several members of a value chain or network (Tuominen and Hyvönen, 2003; Pannekoek *et al.*, 2005; Gellynck *et al.*, 2007; Soosay *et al.*, 2008).

As a consequence, a widely applied validated scale for the measurement of innovation is currently not available. The important challenge lies in developing such a measurement that is overarching in the sense that it grasps the different steps and domains of innovation and that is explicit in the sense that it grasps the specificity of the observed business sector. Further, it should enable the measurement of innovation at company- and value chain-level. In this way, it is a holistic approach which is specific at the same time.

[1] SMEs are companies that employ fewer than 250 people and have a maximum turnover of fifty million Euros

Hence, the aim of this paper is twofold: (1) to propose an approach for innovation measurement which responds to these problems and (2) to evaluate the suitability of this measurement to assess the value chain's innovation capacity (Figure 1).

2. Development of a conceptual framework for investigating innovation capacity

Innovation capacity is the ability to develop innovation, currently, and also in the future (Gellynck *et al.*, 2007). Thereby innovation is understood as a continuous process characterised by three steps: efforts, activities and results. Efforts are all structured R&D resources (e.g. R&D budget) and non-structured R&D resources (e.g. training, study tours and small scale experiences) a firm is investing in innovation activities and possibly leading to innovations. Results are the effects of these activities on tangible (e.g. growth of market share, profit) as well as less tangible aspects (e.g. firm stability, efficiency, and reputation) (Gellynck *et al.*, 2006). This process is cyclical, as the results will influence future innovation capacity.

In this research, we define value chain innovation capacity as a global appraisal of the innovation capacity of the food manufacturing company as well as its main suppliers and customers with whom the food manufacturing company is closely associated. High innovation capacity of the value chain is expected to be achieved when the following conditions are fulfilled: a high innovation capacity at the level of the focal company, a high innovation capacity at the level of its main suppliers and customers and intensive collaboration between the focal company, on the one hand, and its main suppliers and customers, on the other (Roy *et al.*, 2004; Soosay *et al.*, 2008; Weaver, 2008).

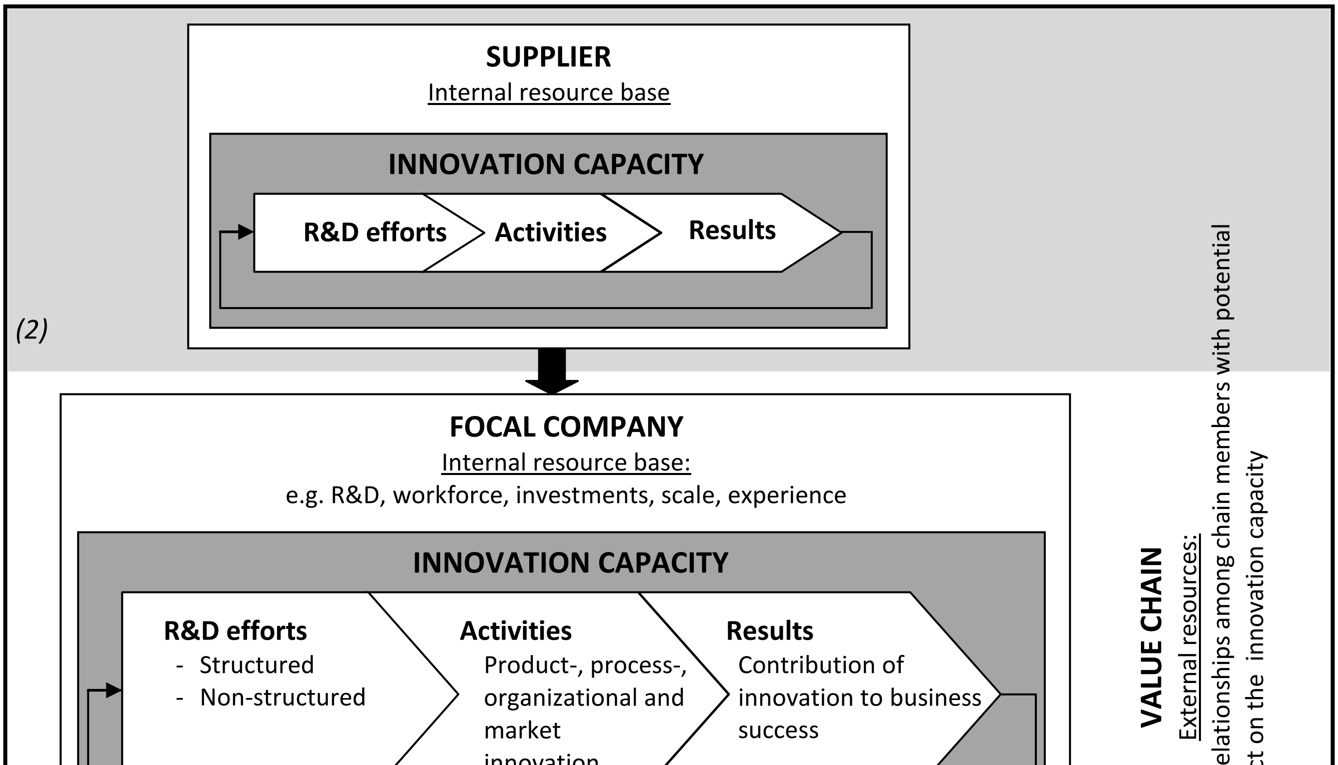

Figure 1: Conceptual framework

(1) and *(2)* refer to the first (i.e. to propose an approach for innovation measurement which responds to these problems) and second part of the research objective i.e. (to evaluate the suitability of this measurement to assess the value chain's innovation capacity) respectively

Our conceptual framework (Figure 1) depicts how the process of innovation is driven by both internal and external resources (Cassiman and Veugelers, 2002). Internal resources refer to the R&D structure and a vast number of firm characteristics such as size, financial structure, qualified staff, experience of the manager and openness to new ideas all have an influence on innovation processes (Grünert *et al.*, 1997; Diederen *et al.*, 2002; Fey 2005). External resources belong to the firm's strategic environment and include the potential of business-to-business relationships, available infrastructure for collaboration and networking, and access to support from research providers and government (Ussman *et al.*, 1999; Avermaete and Viaene 2002; Scozzi *et al.*, 2005). External resources encompass the contextual elements contributing to innovation processes with regard to the inflow of knowledge from other places (Iammarino, 2005). The firm extracts information from a range of commercial and societal actors, such as its suppliers and consumers, on which we will focus in this paper, but also research institutes, universities and governments (Omta, 2004). Consequently, the environment plays an important role for SMEs in the process of developing innovation capacities. In our paper, we consider the value chain to be the place where the internal and external resources of a firm are combined and possibly transformed into innovation capacities (Gellynck *et al.*, 2006). Through the optimal use of both internal and external resources in the value chain, a firm can become innovative and able to achieve sustainable competitive advantage (Lengnick-Hall, 1992; Cassiman and Veugelers, 2002).

In our framework the focus is on the capacity of the firm to perform the innovation process and how the value chain is contributing to it. A broad scope of innovation domains is considered i.e. products, processes, organizational change and market choice. Our approach will focus on the agrifood sector. The low-innovative and low-tech character and the scarcity of radical innovations in the food sector makes it well suited to tackle the identified problems. In particular the agrifood sector is composed of more than 90% of SMEs.

3. Application at company level

In order to verify the conceptual framework for investigating innovation capacity at company level, two surveys were conducted. The first was conducted among small food manufacturing firms exclusively and focused on product- and process innovation, while the second was conducted among agribusiness firms including food manufacturing firms, and their related distribution firms and main suppliers. Here, the focus was on the four domains of innovation recognized in the conceptual framework i.e. product-, process-, organizational and market innovation. Table 1 summarizes the materials and methods used for each of these surveys.

Table 1. Food manufacturing and food firms surveys: Materials and methods

	Survey	
	Food manufacturing survey *(Avermaete et al., 2004)*	Agribusiness' survey *(Gellynck et al., 2007)*
Survey location	Devon and Cornwall region, United Kingdom Hereford and Worcester region, United Kingdom Hainault region, Belgium West Flanders region, Belgium Northwest Border region, Ireland South West region, Ireland	Meetjesland region, Belgium
Survey period	July to December 2001	March and April 2005
Target population	Small food manufacturing firms	Food processing firms Trade firms (wholesale trade) Main suppliers (excluding farmers)
Number of firms surveyed	177	81
Data collection	Structured face-to-face interview	Structured face-to-face interview
Innovation domain	Product- and process innovation	Product-, process-, organizational and market innovation

3.1. Key findings

In the food manufacturing survey, two indicators were applied to measure product and process innovation, both relating to one of the steps of innovation capacity mentioned in the conceptual framework. The first indicator relates to the efforts. As R&D activities are considered to be the main factor in technological development (Avermaete *et al.*, 2004), innovation capacity was first measured based on the percentage of firm's annual turnover spent on R&D activities. Second, in order to cover another aspect of innovation capacity than structured R&D efforts, another indicator relating to the second step of innovation capacity i.e. innovation activities, was also used to measure the firm's innovation: the introduction of substantially modified products or processes over the past five years. Based on these two indicators, the firms are classified in four distinct innovation groups, namely non-innovators, traditionals, followers and leaders. Non-innovators include those firms that have not introduced new or substantially modified products or processes during the past five years. Traditionals are firms that have introduced product- or process innovations, but did not invest in R&D. Followers and leaders are firms that have introduced product- or process innovations and who have invested in R&D activities. Followers spent at most 1% of their annual turnover on R&D whereas in leaders, these expenditures exceeded 1% of the annual turnover.

About 80% of the surveyed firms introduced at least one type of innovation over the past five years (Table 2). Most of the firms are followers (44.1%), having R&D expenditures that represented 1% or less of the firm's annual turnover, followed by the traditionals (21.5%) and the leaders (18.1%). Interestingly, the results indicate that traditional firms which do not invest in R&D, introduced at least one innovation over the last five years. These include, for example, firms that introduced a regional food label in the framework of a regional program such as LEADER, which supports innovation projects undertaken by local action groups. This suggests that investment in R&D alone does not explain a firm's innovation capacity. Networking with other firms or organizations such as public institutions also seems determining.

Table 2. Innovation groups of food manufacturing survey

	Non-innovators	*Traditionals*	*Followers*	*Leaders*
Number of firms (%)	16.4	21.5	44.1	18.1
R&D expenditures as % of turnover	0.17	0	0.5	6.53
Introduction of at least one innovation type (product/process) during the past five years	No	Yes	Yes	Yes

In the agribusiness survey, four variables were selected to measure the firm's innovation capacity: budget in R&D, man-hours in implicit knowledge-acquisition, number of domains of innovation and importance of innovations. The first two variables measure the first step of innovation capacity, namely the efforts. Even though structured R&D investments are widely applied by researchers as an indicator of the firm's innovation capacity, firm's innovation capacity was also measured with the firm's implicit methods of knowledge acquisition, such as education and training, self-study, participation in seminars, field work and small-scale experiments, as research demonstrates that, in particular in the case of SMEs, only a minority of the firms structurally invests in R&D (Avermaete, 2004). The third variable measures the second step of innovation capacity, the innovation activities. It describes the overall innovation activity which is considered as intensive if it is performed in the four mentioned domains of innovation. Finally, the fourth variable measures the last step of innovation capacity, the results. It refers to a general evaluation by the respondent of the importance of innovations to the business success, comprising both tangible (e.g. growth of market share, profit) and less tangible aspects (e.g. firm stability, efficiency) in relation with innovation. This implies that, compared to the food manufacturing survey, three additional aspects have been included. First, the role of implicit or non-structured R&D efforts has been acknowledged. Second, the scope of innovations was broadened by including market and organizational innovation. Third, on top of efforts and activities, also the last step of innovation capacity i.e. results has been measured.

Data of the agribusiness survey were analyzed using hierarchical and k-means cluster analysis on the four variables. Three clusters have been identified, labelled non-innovators, followers and innovators. The distribution in the different clusters is similar to the food manufacturing survey. Followers are the largest group and innovators, equalling leaders in the food manufacturing survey, counts for less than 20% of the total population. However, the relative share of the non-innovators is only slightly lower than the followers. Observing the cluster centres (Table 3), the differences between the clusters are explained primarily by three out of the four variables: budget in R&D, number of domains of innovation and importance of innovation. No significantly difference exists between the clusters regarding implicit knowledge acquisition. Innovators show a significant higher percentage of firms investing in R&D than the other innovations classes; an aspect which is also pointed out in the food manufacturing firms' survey.

Table 3. Characteristics of the clusters

	Clusters			
Variable	*Non-innovators*	*Followers*	*Innovators*	*Significance*
Number of respondents (76)**	**31**	**33**	**12**	
Percentage of respondents	40.79	43.42	15.79	
Mean differences in one-way ANOVA				
Budget in R&D	-0.3[a]	-0.2[a]	0.3[b]	0.007*
Man-hours in implicit knowledge-acquisition	-0.3	0.0	-0.3	0.073
Number of domains of innovation	-1.0[a]	0.5[b]	1.2[c]	0.000*
Importance of the innovation	-1.0[a]	0.5[b]	1.8[c]	0.000*

* Significance < 0.05 (One-way ANOVA).

**Five outliers are removed from the analysis.

Procedure: Hierarchical Cluster Analysis (Ward's method) & subsequent *K*-means method.

Distance Measure: Euclidean Squared Distance.

Mean scores are standardized scores (*Z*-scores).

Letters in superscripts indicates different subsets in Duncan's test, referring to significant differences between group means.

3.2. Evaluation

One remarkable observation is that the non-structured R&D efforts do not discriminate between the clusters. At first sight, this may confirm the view that structured R&D efforts (i.e. R&D investments) are the most reliably proxy to innovation efforts. An alternative explanation could be that it is not the amount of man-hours in non-structured R&D which makes the difference, but the quality and strategic use of non-structured R&D efforts. This should be explored further.

Comparing both approaches, cluster analysis is clearly preferred as it is both logically and statistically more solid. Nevertheless, given the inherent drawbacks of cluster analysis, its use will also depend of the research framework in which it is applied. If the aim is to compare innovation capacity clusters across different populations, it is definitely not the appropriate technique. However, if the aim is to recognize differences within a population, it may indeed result in valid and reliable results.

4. Application at value chain level

For testing the conceptual framework at chain level, a third survey was conducted in 90 value chains (triplet of associated chain members) in the agrifood sector. The focus was on all four domains of innovation. In order to broaden the level of data analysis to the value chain level, an additional variable was introduced covering the aspect of collaboration for innovation between the three chain members i.e. supplier, focal company and customer. Materials and methods are summarized in Table 4.

Table 4. Food chain survey: Materials and methods

	Food chain survey *(Gellynck et al., 2010)*
Survey location	Belgium (cheese and beer) Italy (cheese and ham) Hungary (white pepper, dry sausage and bakery products)
Survey period	December 2007 to June 2008
Target population	Small traditional food manufacturing firms (SMEs) and their respective most important suppliers and customers
Number of chains surveyed	90
Data collection	Structured face-to-face interview
Innovation domain	Product-, process-, organizational and market innovation

4.1. Key findings

Data were analysed using cluster hierarchical and k-medoid cluster analysis on the three steps of innovation capacity i.e. non-structured and structured R&D efforts, innovation activities and innovation results and on collaboration for innovation among the value chain members (Table 5). Three significantly different clusters were found: Poor innovating value chains, Non-collaborative innovating value chains and High collaborative innovating value chains. Poor innovating value chains are chains with low innovation efforts, activities and results, as well as low collaboration for innovation. Non-collaborative value chains are composed of value chain members indicating a higher level of innovation capacity than the members in the first cluster, but not reaching the level of innovation capacity of the value chain members in the third cluster. Furthermore, there is not much collaboration for innovation capacity in this cluster. Finally, high collaborative value chains are composed of value chain members indicating for the majority the highest innovation capacity in comparison to the other clusters as well as intense collaboration for innovation

Table 5: Innovation capacity of value chains, k-medoid cluster analysis, n=90

	Cluster			
	1) Poor innovating value chains	**2) Non-collaborative innovating value chains**	**3) High collaborative innovating value chains**	**K-W Sig.$^{\$}$**
Innovation capacity	n=31	n=49	n=10	
	Cluster centre (Median)	Cluster centre (Median)	Cluster centre (Median)	
Non-structured R&D efforts[1]				
Food manufacturer	0.00^{a}	0.33^{b}	0.50^{c}	0.002
Supplier	0.00^{a}	0.33^{b}	0.63^{c}	0.000
Customer	0.00	0.17	0.33	0.069
Structured innovation efforts[2]				
Food manufacturer	0.00^{a}	0.33^{b}	0.33^{b}	0.000
Supplier	0.00^{a}	0.33^{b}	0.17^{b}	0.000

Customer	0.00[a]	0.00[a]	0.50[b]	0.000
Innovation activities[3]				
Food manufacturer	0.33[a]	0.56[b]	0.72[c]	0.001
Supplier	0.22[a]	0.44[b]	0.44[b]	0.000
Customer	0.33[a]	0.44[a]	0.76[b]	0.002
Innovation results[4]				
Food manufacturer	0.67	0.75	0.83	0.094
Supplier	0.67[a]	0.75[b]	0.67[b]	0.000
Customer	0.67	0.75	0.67	0.215
Collaboration for innovation[5]				
FM-S*	0.00[a]	0.00[a]	1.00[b]	0.000
FM-C*	0.00[a]	0.00[a]	1.00[b]	0.001
S-FM*	0.00[a]	0.00[a]	1.00[b]	0.000
C-FM*	0.00[a]	0.00[a]	1.00[b]	0.002

*Indicates the collaboration for innovation between two value chain members, whereby the first mentioned is answering whether he/she collaborates with the second mentioned, e.g. 'FM-S' refers to the answers of the food manufacturer towards his/her supplier

[a,b] Various superscripts indicate significant differences of group medians in the Mann-Whitney U post hoc test ($p < 0.05$)

[$] Reports estimated significances of the Kruskal-Wallis test

4.2. Evaluation

Cluster analysis proved to be a useful tool for segmenting the chains into groups with similar innovation capacity and collaboration for innovation levels. Thereby, we could show that higher innovation capacity and collaboration for innovation appear at the same time though only few chains in the agrifood sector are on this level yet. However, innovation capacity was only investigated at the company level of the individual value chain members. The contribution of the innovation capacity of one value chain member to the innovation capacity of the other value chain members was not investigated.

5. Conclusion

This study presented an approach for measuring innovation capacity, acknowledging the specific and holistic character of innovation and applying it to SMEs in the agrifood sector. Further, based upon early research findings drawing attention to the importance of collaboration in chains and networks for developing innovation capacity, the approach was extended for measuring innovation capacity at value chain level.

Indeed, the analysis showed that extending the concept of innovation capacity from company to the value chain level delivers valuable results. The finding that value chains differ with respect to their overall innovation capacity reveals that SMEs will perform better when they belong to value chains with intense collaboration between value chain partners in the domain of innovation efforts, activities and results innovation in order to become more innovative. Collaboration is important to gain access to external sources of innovation as value chain members and other partners of the direct environment are the main sources for innovative ideas (Pannekoek *et al.*, 2005; Gellynck *et al.*, 2007).

The conceptual framework and first empirical inquiries result in an applicable and empirically tested scale for measuring innovation capacity The observations proved to be reliable across the different datasets and the inclusion of descriptive variables in the different studies underpin its validity (Avermaete *et al.*, 2003; Gellynck *et al.*, 2006; Gellynck *et al.*, 2007).

However, the findings are drawn from self-reported innovation capacity, which has some essential limitations. Self-reported perceptions are not always trustworthy, as psychological and social processes influence the storage and recall of self-report information (Stone *et al.*, 2000). Further, social desirability and the level of knowledge and experience by the respondent may invoke a bias (Lee *et al.*, 2000). Future research attempts should include a scale in the survey which measures the knowledge level and the effect of social desirability.

For future research it would also be interesting to explore how the benefits of increased innovation capacity are divided between the value chain members and how the level of innovation capacity of each value chain member is contributing to the innovation capacity of each other. Moreover, we encourage the application of our conceptual framework to other sectors and institutional environments in order to test its generalizability.

6. References

Avermaete, T. and J. Viaene, 2002. On Innovation and Meeting Regulation - the Case of the Belgian Food Industry. DRUID Summer Conference on "Industrial Dynamics of the New and Old Economy - who is embracing whom?". Copenhagen/Elsinore. **Theme A**.

Avermaete, T., J. Viaene, Morgan E.J. and Crawford N., 2003. Determinants of innovation in small food firms. European Journal of Innovation Management **6**(1): 8-17.

Avermaete, T., J. Viaene, E. J. Morgan and N. Crawford,, 2004. The impact of firm characteristics and macroeconomic performance on innovation in small food firms: Case study from Belgium, Ireland and UK. Innovation in Small Firms and Dynamics of Local Development. T. de Noronha Vaz, J. Viaene and M. Wigier. Warsaw, Scholar Publishing House**:** 79-95.

Balconi, M., S. Brusoni, and L. Orsenigo, 2008. In Defence of the Linear Model: An Essay. WP n. 216. Milan, CESPRI**:** 35.

Becheikh, N., R. Landry and Amara N., 2006. Lessons from innovation empirical studies in the manufacturing sector: A systematic review of the literature from 1993-2003. Technovation **26**(5-6): 644-664.

Bröring, S., 2008. How systemic innovations require alterations along the entire supply chain: The case of animal-derived functional foods. Journal on Chain and Network Science **8**(2): 107-120.

Cassiman, B. and R. Veugelers, 2002. Complementarity in the innovation strategy: internal R&D, external technology acquisition, and cooperation in R&D, IESE Research Division**:** 21.

Diederen, P., H. v. Meijl, A. Wolters and K. Bijak, 2002. Innovation adoption in agriculture: innovators, early adopters and laggards. Cahiers d'économie et sociologie rurales **67**: 30-50.

Edquist, C. and L. Hommen, 1999. Systems of Innovation: Theory and Policy for the demand side. Technology In Society **21**: 63-79.

Enzing, C. M., F. H. A. Janszen and O. S. W. F. Omta (2008). The impact of the openness of the innovation process on the short term and the long term market performance of new products: Evidence from new product announcements of the Dutch food and drinks industry. 8th International Conference on Management in AgriFood Chains and Networks. Ede, The Netherlands, Wageningen Academic Publishers.

Fey, C. F., 2005. External sources of knowledge, governance mode, and R&D performance. Journal of Management **31**(4): 597-621.

Fischer, M. M., 2001. Innovation, knowledge creation and systems of innovation. Annals of Regional Science **35**(2): 199-216.

Gellynck, X., B. Vermeire and J. Viaene, 2006. Innovation in the food sector: regional networks and internationalisation. Journal on Chain and Network Science **6**(1): 21-31.

Gellynck, X., B. Vermeire and Viaene J., 2007. Innovation in food firms: Contribution of regional networks within the international business context. Entrepreneurship & Regional Development **19**(3): 209-226.

Grünert, K., H. Harmsen, M. Meulenberg, E. Kuiper, T. Ottowitz, F. Declerck, B. Traill and G. Göransson, 1997. A framework for analysing innovation in the food sector. Product and process innovation in the food sector. B. Traill and K. G. Grunert. Suffolk, Chapman & Hall**:** 1-33.

Grunert, K. G., B. B. Jensen, Sonne A.M., Brunso K., Byrne D.V., Clausen C., Friis A., Holme L., Hyldig G., Kristensen N.H., Lettl C. and Scholderer J., 2008. User-oriented innovation in the food sector: relevant streams of research and an agenda for future work. Trends in Food Science & Technology **19**: 590-602.

Kirner, E., S. Kinkel and Jaeger A., 2009. Innovation paths and the innovation performance of low-technology firms--An empirical analysis of German industry. Research Policy **38**(3): 447-458.

Lee, E., M. Hu and Toh R.S.,2000. Are Consumer Survey Results Distorted? Systematic Impact of Behavioral Frequency and Duration on Survey Response Errors. Journal of Marketing Research **37**: 125-133.

Lengnick-Hall, C. A., 1992. Innovation and Competitive Advantage: What We Know and What We Need to Learn. Journal of Management **18**(2): 399.

Lundvall, B. A., 1995. National systems of innovation: towards a theory of innovation and interactive learning. London, Biddles Ltd.

Maravelakis, E., N. Bilalis, Antoniadis A., Jones K.A. and Moustakis V, 2006. Measuring and benchmarking the innovativeness of SMEs: A three-dimensional fuzzy logic approach. Production Planning and Control **17**(3): 283-292.

OECD, 2005. Oslo Manual - Guidelines for collecting and interpreting innovation data, OECD/European Communities.

Omta, O., 2004. Management of Innovation in Chains and Networks. The Emerging World of Chains and Networks. Bridging theory and practice. T. Camps, P. Diederen, G. J. Hofstede and B. Vos. 's-Gravenhage, Reed Business Information.

Omta, O. S. W. F., 2002. Innovation in chains and networks. Journal on Chain and Network Science **2**(2): 73-80.

Pannekoek, L., O. Van Kooten, Kemp R. and Omta S. W. F., 2005. Entrepreneurial innovation in chains and networks in Dutch greenhouse horticulture. Journal on Chain and Network Science **5**(1): 39-50.

Petroni, A. and B. Panciroli, 2002. Innovation as a determinant of suppliers' roles and performances: An empirical study in the food machinery industry. European Journal of Purchasing & Supply Management **8**: 135-149.

Pittaway, L., M. Robertson, K. Munir, D. Denyer and A. Neely, 2004. Networking and innovation: a systematic review of the evidence. International Journal of Management Reviews **5-6**(3-4): 137-168.

Powell, W. W., K. W. Koput and L. Smith-Doerr, 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. Administrative Science Quarterly **41**(1): 116-145.

Rothwell, R., 1992. Successful industrial innovation: critical success factors for the 1990's. R&D Management **22**: 221-239.

Sarkar, S. and A. I. A. Costa, 2008. Dynamics of open innovation in the food industry. Trends in Food Science & Technology **19**: 574-580.

Scozzi, B., C. Garavelli, Crowston K., 2005. Methods for modeling and supporting innovation processes in SMEs. European Journal of Innovation Management **8**(1): 120-137.

Soosay, C. A., P. W. Hyland and Ferrer M., 2008. Supply chain collaboration: Capabilities for continuous innovation. Supply Chain Management: An International Journal **13**(2): 160-169.

Stewart-Knox, B. and P. Mitchell, 2003. What separates the winners from the losers in new food product development. Trends in Food Science & Technology **14**: 58-64.

Stone, A., C. Bachrach, Jobe J.B., Kurtzman H.S. and Cain V.S., 2000. The science of self-report: Implications for Research and Practice New Jersey London, Lawrence Erlbaum Associates.

Tidd, J., J. Bessant and K. Pavitt, 2005. Managing innovation. West sussex, John Wiley & Sons, Ltd.

Tuominen, M. and S. Hyvönen, 2003. Organizational Innovation Capability: Creating and Appropriating Value in Channel Relationships. 19th Industrial Marketing and Purchasing Group Conference. Lugano, Switzerland.

Ussman, A., M. Franco, L. Mendes and A. Almeida (1999). Are SMEs Really Innovative? A Study Regarding the Main Difficulties in Portuguese SMEs. Conference Paper No. 78, Conference of the International Council for Small Business (ICSB). Naples / Italy, Small Business Advancement National Center.

Varsakelis, N. C., 2006. Education, political institutions and innovative activity: A cross-country empirical investigation. Research Policy **35**(7): 1083-1090.

Weaver, R. D., 2008. Collaborative Pull Innovation: Origins and Adoption in the New Economy. Agribusiness **24**(3): 388-402.