

WAGENINGEN UNIVERSITY

Effect of Broker Services on Innovation Performance in a Dutch Agri-food Innovation System

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Management summary

Introduction

Innovation is one of the most important drivers of business success. Companies and governments alike recognize the importance to increase the level of innovation and technological change on company, industry and national level. Innovations are no longer regarded as standalone accomplishments but depend on all societal subsystems. Therefore, innovation is more often seen from a system approach.

All actors, networks and institutions who contribute to developing, diffusing and utilizing new products and processes are the components of an innovation system. Failure of a system to innovate adequately, due to either cognitive, information and/or managerial gaps create the need for intermediary organizations, organized by (semi)-public organizations to increase innovativeness.

Innovation brokers (IB) are an example of intermediary organization. The innovation broker is acting as a member of a network with the purpose of enabling the other companies to innovate. In literature, four main functions are found for innovation brokers, namely: network formation, demand articulation, innovation process management and internationalization.

These functions are broad and highly discussed in literature, yet studies that focus on the tangible activities performed by innovation brokers and on measuring their effects are limited. This research aims to help fill the gap by shedding light on the effect of innovation brokers on companies' innovative performance, translated by product, process, marketing and organizational innovations.

The main question for this research is:

How do different services provided by an innovation broker impact the innovation performance of companies that make use of them?

Due to its broadness, the research question was divided into sub-questions focusing on each of the four categories of services.

Research Methodology

The research domain focuses on Food Valley NL, an important innovation broker active in both the Dutch and the international Agri-food industry, created with the objective of stimulating demand-driven innovation. Results from two web-based surveys conducted among the active members of Food Valley NL and non-members that made use of its services have been used. The two data sets (from 2009 and 2011) offered information concerning the use of broker services, external company collaboration and types of realized innovations in both years.

Company characteristics such as size (SME/large), type (food processors, ingredient providers, technology/knowledge providers, consultants) and dependence (independent companies/part of multinational corporations) were important criteria used in the research while descriptive statistics as well as probit and ordered probit regression represented the methods for data analysis.

Results

Although the use level of the activities was characterized as rather low (less than 35% for most services excluding information sources and network formation general services), several interesting results were found in between group comparisons: 19% of the SMEs used internationalization support as opposed to large companies that did not use the service at all, while from the different company types, food processors made the most use of innovation process management support (35% usage rate). Also, 22% of the organizations that were not part of multinational corporations and therefore had an independent activity proved interested in finding foreign counterparts for cooperation and new project development versus multinationals that did not use the service.

In terms of innovation performance, the amount of process and organizational innovations scored double in the period 2009-2011 than in the previous three years. Technology/knowledge providers had the greatest levels of marketing innovation (66%) whereas ingredient providers appeared to have developed the most cooperative partnerships (82%).

From the four innovation broker functions, all but demand articulation affected the likelihood of companies performing innovations, with the more specific services and activities underpinning such functions having significant positive effects.

Conclusions

The influence of Food Valley is mostly found in the areas of network formation, innovation process management and particular international matchmaking services. With this, Food Valley NL seems to fit into innovation brokerage literature quite well. The cause of certain negative influences of some of the services/activities on the companies' innovation performance remains unclear.

From the organization characteristics investigated, only company type proved to have significant influence on innovation performance. Being a technology/knowledge provider increased the chance of actors innovating in terms of customer types and market areas whereas ingredient providers are more inclined towards organizational innovation.

Recommendations

For future research, a company perspective might be useful for other innovation brokers who want to assess the relevance of their activities. More exploration is needed, preferably from a qualitative angle. Closed inquiries do not seem effective enough in capturing the reasoning behind service use/non-use as well as the link between the broker activity and the exact contribution to the companies' performance. One suggestion here would be to perform qualitative interviews using the laddering technique.

In terms of recommendations for Food Valley NL, the focus should be more on the specialized services concerning the IB functions, (e.g. Finding partners to innovate, International matchmaking) since they appear to have significant effects on the likelihood of innovation performance of companies. Also, based on the low usage rate of services, the organization should consider intensifying its advertising efforts. The newsletter and website are suitable channels, since they proved to be highly read/ accessed; nonetheless other possibilities need to be found.

TABLE OF CONTENTS

Management Summary.....	3
1. Introduction.....	7
2. Theoretical background	9
2.1. Innovation Systems	10
2.2. Innovation brokers	11
2.3. Functions of Innovation Brokers.....	12
2.4. Conceptual Model	15
3. Research Methodology.....	18
3.1. Research Domain.....	18
3.2. Methods of Data Collection and Analysis	19
4. Results	23
4.1. Use of innovation broker services	26
4.2. Realized innovations	30
4.3. Results of probit analysis	34
4.4. Results of ordered probit analysis	36
5. Conclusions.....	39
5.1. Conclusions on research methodology	39
5.2. Answering the research question and hypothesis testing	39
5.3. Conclusions on the other elements of the conceptual model	42
6. Recommendations	43
References	44
Appendix	49

1. Introduction

The aim of the “Lisbon Agenda” as defined by the European Union in 2000 was to make the EU “the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion”.

The strategy identifies knowledge as the main source of economy development and is heavily based on the concepts such as “innovation as the motor of economic change”, “the learning economy” and “social and environmental renewal”. Translation of the Lisbon Agenda goals into concrete measures required the development of Framework Programmes for Research and Technological Development (FPs) and Joint Technology Initiatives (JTI), that have been designed for the different aggregation levels ranging from the level of countries, industrial sectors, to single companies and the micro level illustrated by innovation projects within a company. The reason for these measures is that innovation has become a key to sustainable growth and economic development not only at company level, but also at region and country level, impacting country competitiveness in global economy (Fagerberg, 2006). The focus here is on open innovation, where knowledge external to the firm is the key to innovation, as pure, closed R&D is not considered to be sufficient anymore for economic growth.

The concept of Innovation System is most commonly used for country sector levels. An innovation system represents a combined structure of different actors, knowledge and institutions that together create innovation. Depending on the level of inquiry, an innovation system can be national, regional or sectoral. The Regional Innovation System (RIS) concept has gained a dominant position within European technology and innovation policies. The concept should contribute to the Lisbon Strategy by increasing European competitiveness by the cumulative result of knowledge-driven regional economic systems.

According to Klerks & Leeuwis (2008a), the performance of any innovation system depends on appropriate connectivity of the actors (private firms, public organizations,

research organizations etc.) and on the combined elements of the system: hardware (material equipment), software (knowledge in terms of manuals, digital content, software, tacit knowledge involved in the innovation) and orgware (institutional and organizational conditions that impact the development of an invention into an innovation and the actual functioning of an innovation). The existence of gaps (cognitive, information and managerial) can influence this performance, reducing the options of connectivity and combination within the system. With the scope of minimizing these gaps, there is a growing interest for “systemic intermediaries” that connect the different elements of international, national, sectoral and /or regional innovation systems. Important roles of these intermediaries are: the creation of interaction spaces, the reduction of transaction costs for inter-systemic and interdisciplinary cooperation and the maintenance of dynamic, self-organizing systems.

One such innovation intermediary is Food Valley NL. The organization targets food producers and related technology and service providers from Dutch regional and national levels as well as globally. Its main concentration of members is located around Wageningen University (Gelderland, The Netherlands), region that can be described as a knowledge cluster composed of international food companies, research institutes, a science park, start-ups and innovative clusters (nanotechnology, genomics, horticulture) and that is viewed as an important example of innovation production and economic development. Food Valley NL offers different services for the members and organizes activities with the aim of dissipating information (van Klink, 2010) and promoting the innovativeness of Dutch companies. The four main types of services offered are demand articulation, network formation, innovation process management and internationalization.

As innovation brokers promote open innovation, the aim of this research is to study how each of the four functions of these mediating organizations influences the innovation performance, and furthermore the business performance of companies that make use of IB services. Aspects play a key role in the research are: company size (large/SMEs),

company type (food processors, ingredient providers, technology/knowledge providers, consultants) and company dependence (part of a multinational or not).

The main research question is: “How do different services provided by an innovation broker impact the innovation performance of companies that make use of them?” In finding the answer, sub questions are used to refer to each function of IBs:

- How do demand articulation support services impact the innovation performance of companies that make use of them?
- How do network formation support services impact the innovation performance of companies that make use of them?
- How do process management support services impact the innovation performance of companies that make use of them?
- How do internationalization support services impact the innovation performance of companies that make use of them?

2. Theoretical background

It has been widely recognized that innovation represents one of the most important drivers of business success (Porter 1985). In accordance to this, companies and governments alike thrive to increase the level of innovation and technological change in the company, industry and national levels. As a solution to succeeding in the present highly dynamic and “diffused knowledge environment”, Chesbrough (2003) promotes an open form of innovation, in which companies work together as part of a system, as opposed to the older, closed innovation model in which in-house R&D departments provided for new products and processes. Thus, innovation becomes highly context (innovation system) dependent. Regional innovation systems represent groups of regional actors, networks and institutions that generate a collective learning process within related technological or functional areas. Such collaboration encourages the rapid diffusion of knowledge, skills and best practices within the system and is highly dependent on the quality and connectivity of its actors. If gaps in connectivity and collaboration appear, the performance of an innovation system decreases. Because of

the crucial importance of competitiveness in regions and sectors, cluster organizations, also called innovation brokers, intermediary organizations or innovation intermediaries have been organized. Their scope is to minimize the system's gaps and to enhance its connectivity. This study aims to continue previous research (Howells, 2006; Winch and Courtney, 2007; Klerkx and Leeuwis, 2008a; Batterink et al, 2010, Omta and Fortuin, 2012) concerning the effectiveness of innovation broker functions (services) on promoting open innovation within innovation systems.

2.1. Innovation Systems

The innovation system (IS) approach to the production of scientific and technological knowledge has been gaining importance in policy and academic circles over the last two decades (Carlsson, 2006). The approach represents a major change in how production of knowledge is viewed and supported. It shifts attention away from companies innovating in isolation towards a triple helix innovation model based on university-industry-government relations. This new system is composed of firms and organizations such as universities, innovation centers, educational institutions, financing institutions, industry associations, government agencies and standard setting bodies that together embark in an evolutionary, dynamic and interactive process of collaboration (Todtling and Trippl, 2005).

Initially, the IS approach has been applied to the national level (Lundvall 1992, Nelson 1993, OECD 1999). The concept has derived from technology and innovation policy as has been used in the development, analysis and benchmarking of innovation policies. It includes a shared culture or language and the attention of national policies, legislation and funding that influence the innovation system environment (Lundvall 2002).

Later, the concept of Regional Innovation Systems (RIS) was introduced (Malerba, 2002; Carlsson, 2006). In the last years, increased interest has been shown by policy makers and social scientists to regions as locus of innovation and competitiveness in the globalized economy. Most research has been based on the fact that territorial agglomeration provides the best context for an innovation-based global economy (Asheim et al, 2005). There are several characteristics that support this find. First,

regions differ in terms of their industrial specialization and innovation performance (Howells, 1999; Breschi, 1999). Second, it has been described that knowledge spillovers have often spatially bounded. A third aspect is the importance of tacit knowledge for successful innovation. Intensive personal contacts based on trust are required for such knowledge exchange and are facilitated by geographical proximity. It is known that institutions and policy competences are relatively bound to subnational spaces (Todtling and Trippl, 2005) and that competitiveness that occurs in places where localized capabilities such as specialized resources, skills, institutions and share of social and cultural values is a central factor that gives rise to regional development (Doloreux and Parto, 2004).

2.2. Innovation brokers

According to Klerks & Leeuwis (2008a), the performance of any innovation system depends on appropriate connectivity of the actors and on the combined elements of the system: hardware, software and orgware. If gaps in connectivity and collaboration appear, the performance of an IS decreases (Bergek et al., 2008). Because of the crucial importance of competitiveness in regions and sectors, clusters and networks are organized by (semi-)public organizations in order to increase innovativeness (Beckmann et al., 2007).

The literature that focuses on the concept of innovation systems defines these clusters and networks as innovation intermediaries or innovation brokers (IBs) (Klerks & Leeuwis, 2006). The concept “innovation intermediary” can be defined as “an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties”, denoting a range of different bodies. Because of the many role possibilities, they can be defined as intermediary firms, brokers, information intermediary organizations, third parties and bridges (Howells, 2006).

These organizations have been studied from different perspectives: the sector i.e. agriculture sector (Klerks & Leeuwis, 2008c), the process of innovation (Howells, 2006), specific roles i.e. orchestrator (Batterink, 2009), kind of relationship i.e. university/industry (Johnson, 2008), specific function, i.e. demand articulation (Boon,

Moors Kuhlmann & Smits, 2008). From here we can see that the specific roles and characteristics of innovation intermediaries depend on the reason for which they have been created, in some cases the innovation intermediation role can be a secondary activity.

The term “innovation broker” distinguishes those innovation intermediaries that have a broker role as their main function (Whinch & Courtney, 2007). They are “facilitators of innovation” and act as a member of a network of actors part of an industrial sector that are focused on enabling organizations to innovate, and not on the generation or implementation of innovations (Den Hertog, 2000; Klerks & Leeuwis, 2009, van Lente et al., 2003; Winch et al., 2007).

Innovation brokers appeared due to a perceived suboptimal level of connectivity between actors, due to innovation system or market failures. In the last years, a new type of “innovation broker” has emerged, with functions at network level, as opposed to the traditional intermediary organizations that mainly operate in a bilateral manner (Klerks & Leeuwis, 2009; Smits et al., 2004; van Lente et al., 2003). At the network level, this type of intermediaries that have an “animator” role, create new possibilities and dynamism, increasing the connectedness within the system. They also help reduce the uncertainty in the early stages of the innovation process, when the risk of failure is high and would preclude private parties from innovating (Klerks & Leeuwis, 2009; Smits et al., 2004; van Lente et al., 2003).

2.3. Functions of Innovation Brokers

While investigating intermediation and the role of intermediaries in the innovation process, various authors (van Lente et al., 2003; Klerks & Leeuwis, 2008b; Batterink, 2010) identify the following services: demand articulation, network formation and innovation process management. A fourth function, namely internationalization has fallen under the scope of innovation literature more recently (Omta and Fortuin, 2012). Following this classification the most important characteristics of these functions are presented:

- **Network formation:** the purpose of this function is to close the information gap of the innovation system and to facilitate the linkages between actors (scanning, scoping, filtering, and matchmaking of possible cooperation partners) with the purpose of enhancing system connectivity (Howells, 2006).
- **Demand articulation support:** for clarifying both demand and support it is necessary to express innovation needs in terms of knowledge, technology, funding and policy. This includes the search for technological variety and for possible applicants. Innovation intermediaries facilitate the creative process with the purpose of determining the real needs of the actors that are part of the innovation system. Batterink (2010) connects this function to “innovation initiation”.
- **Innovation process management:** this function supports the alignment of actors from different institutional backgrounds and with different norms, values, incentive and reward systems within the network. Continuous “interface management” is needed (Smits & Kuhlmann, 2004), translated by bridging the cognitive and cultural differences between different “knowledge domains”, “boundary work” (Kristjanson et al., 2009) or “knowledge brokerage” (Hargadon,2002). It also includes tasks that enhance the sustainability and productivity of the network: the establishment of working procedures, the building of trust, learning development, conflict management and international property management (Leeuwis, 2004).
- **Internationalization:** In the context of promoting innovation, intensifying competition and accelerating technological change extra-regional contacts which complement the local ones are highly important (Doloreux and Parto, 2004). This function aims at facilitating international linkages between companies and at creating international exposure. Having access to actors from different innovation systems is a source of competitive advantage. It provides a variety of knowledge sources that help generate inputs and thus, enhance economic activity (Asheim and Gertler, 2004).

Referring to Huston and Sakkab (2006) “Connect and Develop” paradigm, previous research (Omta and Fortuin, 2012) discusses the importance of network formation

support offered by innovation brokers in identifying potential network partners and enhancing absorptive capacity.

The term “absorptive capacity” describes an organization’s ability to value, assimilate and apply new knowledge (Cohen and Levinthal, 1990). Two types of absorptive capacity have later been defined: potential absorptive capacity, which is crucial for the acquirement and assimilation of external knowledge and realized absorptive capacity, which refers to how the attained knowledge has been transformed and exploited (Zahra and George, 2002).

The lack of absorptive capacity among small firms has become a significant factor in innovation diffusion and has determined a wide range of policy intervention. Through their information services and supporting firm-level consultancy, innovation brokers have the responsibility to upgrade the performance of actors within their networks and thus increase absorptive capacity levels (Bessant et al, 2012).

Innovation brokers initiate change by assisting the transformation of the ideas and knowledge being transferred (Howells, 2006). Nevertheless, it is up to the companies to further use the ideas, develop innovations and bring them to the market.

There are two main theoretical perspectives that provide understanding as to how a firm can gain and maintain the competitive advantage needed for its success. These are the industrial organization perspective (outside-in approach) and the competence perspective (inside-out approach). The first is externally oriented and implies that the business environment strongly influences the strategies potentially available to firms while the second focuses on the company’s own resources, competencies and capabilities that together are said to form a socially complex and difficult to replicate phenomena which represents starting point for gaining competitive advantage. The two perspectives are complementary to understanding internal and external fit, and finally the process of strategic alignment, mediated by innovation brokers (Fortuin, 2007).

In order to answer the research question, an innovation facilitator that covers services underpinning all four functions of innovation brokers has been identified. Food Valley

Organization meets these requirements, representing a successful innovation broker regionally organized and primarily active in the Dutch agri-food industry.

A conceptual model has been developed in the attempt of getting more insight in the contribution of Food Valley NL's services to the realized innovations of companies. Before introducing the model, it is highly important to remember the fact that innovation brokers usually play intangible roles that are very difficult to capture through conventional indicators (Kelks et al, 2009).

2.4. Conceptual Model

In this subchapter, the conceptual model (Figure 2.1.) used for the research will be introduced and described according to its constitutive elements.

By definition, an innovation broker represents “an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties. Such intermediaries activities include: helping to provide information about potential collaborations; brokering a transaction between two or more parties; acting as a mediator, or go-between, bodies or organizations that are already collaborating; helping find advice, funding and support for the innovation outcomes of such collaborations” (Howells 2006).

As innovation broker functions have been introduced in the earlier section, it is therefore interesting to investigate whether or to what extent these impact the innovation outcomes of companies. Intermediary services will represent the independent variables, thus the starting point of the model whereas innovation performance will be described using the Oslo Manual classification: product innovation, process innovation, marketing innovation and organizational innovation.

Previous research (Omta and Fortuin, 2012), in accordance to open innovation literature argues that network formation support, aimed at bringing actors together is considered the most important and effective role of innovation brokers. Therefore, following the conceptual model, it can be hypothesized that:

H: Services underpinning network formation support have the strongest positive influence on company innovativeness compared to other innovation broker services.

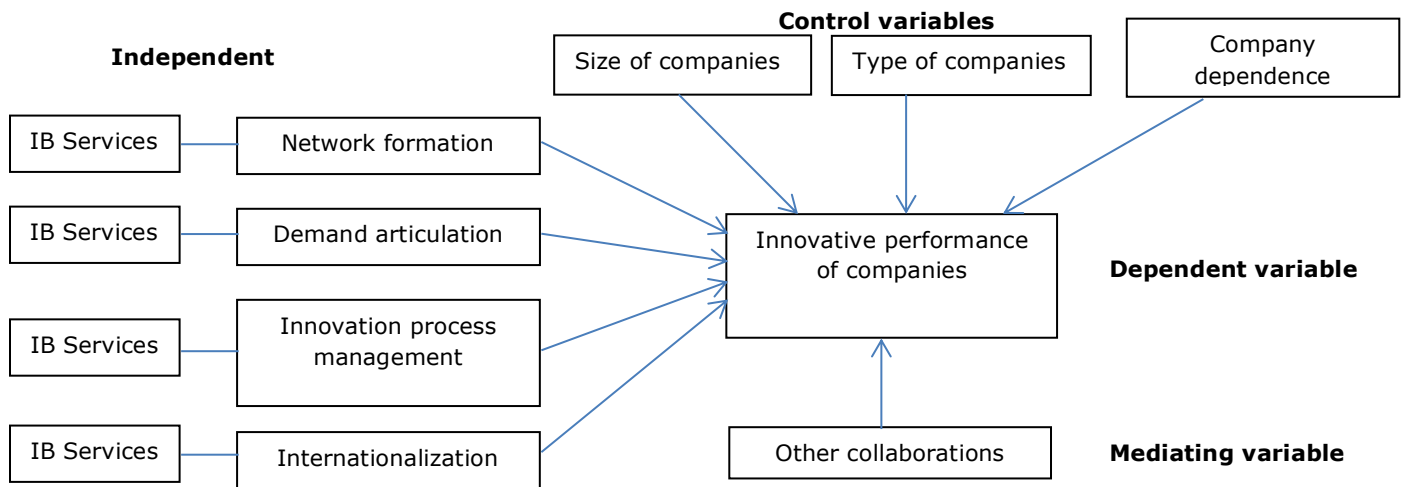
An important aspect to consider when referring to innovation diffusion is the size of companies: it is more challenging for SMEs to innovate, as opposed to large companies that already have the necessary resources and relationships to do so (Kemp et al, 2003). It can be assumed that intermediaries provide a significant contribution to SMEs concerning the access to and utilization of external knowledge, enabling them to innovate, but do these companies possess the competencies and capabilities required for achieving high levels of innovation?

A distinction between independent companies and firms that are part of multinational corporations (MNC), either as subsidiaries or as parent companies, is made. The purpose is to investigate whether being part of a broader system, and therefore having access to different resources leads to supplementary innovation.

Different types of companies have diverse needs and therefore might benefit from intermediary services accordingly. A distinction between food processors, ingredient providers, technology/knowledge providers and consultants has been made. It will be investigated which type of companies use and benefit the most from each innovation broker category of services.

The open innovation theory postulates that external collaboration supports innovation in positive ways. In the following model, “other collaborations” is used as a mediating variable to see whether collaboration with external actors has a significant impact on the innovation performance of companies.

Figure 2.1. Conceptual model



3. Research Methodology

3.1. Research Domain

Food Valley NL is an important innovation broker active in both the Dutch and the international Agri-food industry, created in 2004 by the collaboration of triple helix actors (business, knowledge institutions and government) with the objective of stimulating demand-driven innovation. The organization offers its members, mainly food producers and related technology and service providers, guidance and support in identifying relevant knowledge, information and potential partners as well as national and international matchmaking & technology scouting possibilities.

Food Valley NL is a public-private partnership, its main funding comes from the government, while companies contribute by paying an annual membership fee. Companies become members only by invitation and are then provided with privileged activities and information sources, which non-members do not have access to. Currently FV consists of 105 companies, from which 62% are SMEs and 38% large companies. According to their specializations, members can be grouped in several categories: food processors, technology providers, ingredient suppliers and service providers (Omta and Fortuin, 2012).

Food Valley Functions

The Food Valley NL support functions analysed in this study are categorized according to literature as follows: demand articulation, network formation, innovation process management and internationalization. The services provided by Food Valley NL are correlated to the specific innovation broker functions as follows (see Appendix 1 for a detailed explanation):

Demand articulation support: tailor-made market intelligence, assistance in applying for subsidies services and trend reports.

Network formation support: FV conference, open innovation seminars, innovation partner search and FV Society meetings.

Innovation process management support: the innovation link (to researchers and engineers from Wageningen University), the FV website and newsletter.

Internationalization support: FV Ambassador Program (researchers and business managers from other countries advertising the skills of FV member companies in their home country), exposure at the International Food Expo and international matchmaking service.

Research Population

The research population consists of all companies that are members of Food Valley NL and/or made use of its services in 2009 and 2011, respectively.

Four types of companies can be identified: food processors, ingredient providers, technology/knowledge providers and consultants. As presented in Appendix 1, the innovation broker offers companies access to activities, services and information sources. Activities refer to meetings and conferences that aim at information sharing and networking among members, services are customized and help companies in applying for subsidies and finding innovation partners, while information sources represent different types of information made available via the website, newsletters, or other publications.

3.2. Methods of Data Collection and Analysis

For the study, two web-based questionnaires were sent to the research population in 2009 and 2011. The aim of the questionnaire was to evaluate the activities, services and information sources of Food Valley NL, as well as to highlight the way in which these contributed to the companies' innovation performance. The two questionnaires contained the same questions, with the difference that in 2011 some services and activities were evaluated in more detail. The responses were coded using 7-point Likert scales (1= not at all important; 7=very important). The advantages of this method are that it is easy for respondents to submit the questionnaire and the procedure is inexpensive (Baarda and de Goede, 2006). In both years, two weeks after sending the questionnaire, non-responding companies received a reminder and one week later were

called in order to increase the response rate. Companies that joined the organization and cancelled their membership in the same year or had never made use of any of the services provided by Food Valley NL are labelled non-eligible.

The two data sets offer information about how companies perceived the importance and quality of FV activities and services in those two years, how often they made use of them and what was the perceived effect on their innovation activities. Another important part of the surveys consisted in assessing collaboration. It was inquired whether they collaborate with other organizations and how important certain partner categories are in the collaboration process. From this inquiry, only the main question was relevant for the conceptual model, namely whether the companies collaborated externally or not. Lastly, respondents were requested to rate their innovation performance, translated by which types of innovations have been implemented in the company in the preceding three years.

A common data base was created only with the relevant information for the proposed conceptual model, namely the use of services, the external collaborations and the types of realized innovation in 2009 and 2011 surveys. In some cases, questions had to be merged and the coding of the answers modified to obtain a narrower scale. Dummy variables have been added such as: year of measurement (2009/2011), size (SME/ large company) and type of company (food processor, ingredient provider, technology/knowledge provider, consultant), as well as two indicators that show if the company is independent or part of a MNC and whether it is a FV Society member or not.

All activities, services and information sources of Food Valley NL were categorized according to their nature, as presented in the conceptual model: network formation, demand articulation, innovation process management and internationalization. Each category was later on divided in two sub-categories, based on the more general (examples: meetings, conferences, trend reports, website and newsletter) or targeted (examples: examples: finding partners to innovate, assistance in applying for subsidies, innovation link) character of the services underpinning each innovation broker function.

Table 3.1. Categorization of Food Valley NL broker services

Service/Activity/Information source	Category	Sub-category
FV Conference	Network formation	General
Open innovation seminars		
Finding partners to innovate		Targeted
Market Intelligence Trend Reports	Demand articulation	Market info
Tailor-made Market Intelligence		Funding
Applying for Subsidies		
FV website	Innovation process management	Information
FV newsletter		
Innovation Link		Support
FV ambassador program	Internationalization	Participation
IFV Food Expo		Matchmaking
International Matchmaking		

Innovation performance was expressed by grouping the innovations according to the Oslo Manual (2005) into: product innovation (new or improved products or services), process innovation (new or improved processes), marketing innovation (new market segment and new market area) and organizational innovation (new cooperative partnerships).

Table 3.2. Categorization of questionnaire elements reflecting innovation performance

Innovation element	Innovation type
Product innovations Patents	Product innovation
Process innovations	Process innovation
New market segments or different customer types New market areas	Marketing innovation
New partnerships	Organizational innovation

For the first part of the analysis, descriptive statistics were used to quantitatively define the main features of the data set. One way analysis of variance (ANOVA) was performed to test whether there were differences in service use and innovation performance of organizations according to company characteristics. The analyses were completed with the statistical software SPSS, version 19. A p-value of below 0.10 was considered significant and $p < 0.05$ was interpreted as highly significant.

The second part of the study consisted of probit and ordered probit statistical analysis and was done with Stata SE 10 software. The significance was reflected by a p value of below 0.1.

A probit model is a type of regression where the dependent variable can only take two values, for example member or non-member. The name is from **probability + unit**. The purpose of the model is to estimate the probability that an observation with particular characteristics will fall into a specific category. The estimation focuses on the maximum likelihood method, as opposed to ordinary least squares (OLS) that uses the moment based method. Ordered probit is a generalization of the probit analysis to the case of more than two outcomes of an ordinal dependent variable.

The two types of regression analysis, probit and ordered probit cannot be consistently estimated using OLS, used in linear regression analysis, because such a method can no longer produce the best linear unbiased estimator (BLUE), being biased and inefficient (Park, 2009)

4. Results

This chapter will start with an overview of the responses from the two measurements and a preliminary analysis of the outcomes. Further on, the results obtained after applying the conceptual model will be presented.

For the 2009 research, companies that joined the organization and also cancelled their membership in the same year or had never made use of any of the service provided by FV were labelled non-eligible. A number of 47 out of the 70 eligible companies responded to the questionnaire, a response rate of 67%. Apart from the FV members, 6 non-member companies have been added to the effect measurement.

In 2011, the web-based questionnaire was sent to a wider population due to the high number of participants to the FV seminars. From the total of 155 respondents, 56 respondents completed the questionnaire, a response rate of 36%.

After combining the two data files and removing respondents that would risk to bias the outcomes due to too many not-answered questions, a new data base was created, composed 98 companies. Therefore, based on the overall study sample of both years, namely 231 respondents, the response rate was 42, 42%.

The 98 companies were grouped as follows: 37 food processors, 11 ingredient providers, 32 technology/knowledge providers, 16 consultants and 2 anonymous respondents in 2011. A more detailed description can be seen in the following table:

Table 4.1. Respondent baseline description

		2009	2011	2009 and 2011
Number of respondents (companies)		49	49	98
FVS membership	Members	43	38	81
	Non-members	6	11	17
Size	SMEs	37	33	70
	Large companies	12	14	26
Dependence	Independent companies	32	26	58
	Companies part of multinational corporations	17	21	38
Type	Food processors	17	20	37
	Ingredient providers	7	4	11
	Technology/knowledge providers	18	14	32
	Consultants	7	9	16

As expected (innovation brokers mainly target small and medium commercial actors), 77,78% of the respondents are SMEs, primary companies that have a FV Society membership. Concerning type, the majority (37%) is composed of food processors.

Before proceeding to the descriptions of service use and innovation performance according to the control variables, it is essential to acknowledge the way in which the independent variables used for testing the conceptual model have been grouped:

Table 4.2. Grouping of variables and response overview

			Positive answers	Negative answers
		FV Conference participation	57	41
Network formation	General	Open innovation seminars participation	49	49
		Use of "Finding partners to innovate" service	12	86
	Targeted			
Demand articulation	Market info	Use of "Market Intelligence Trend Reports"	60	48
		Use of "Tailor-made Market Intelligence" service	18	80
	Funding	Use of "Applying for Subsidies" service	9	89
Innovation process management	Information	Use of FV website	81	17
		Use of FV newsletter	78	20
	Support	Use of "Innovation Link" service	15	83
	Participation	Use of "FV ambassador" program	17	81
Internationalization		IFV Food Expo participation	13	85
	Matchmaking	Use of "International Matchmaking" service	13	85
Collaboration		External collaboration	48	50
Product Innovation		Realized product innovations	69	29
		Realized patents	32	66
Process innovation		Realized process innovations	45	53
		Realized new market segments or different customer types	46	52
Marketing innovation		Realized new market areas	46	52
Organizational innovation		Realized new partnerships	55	43

Table 4.2. shows higher levels of negative responses concerning specialized services (finding partners to innovate, applying for subsidies, international matchmaking), compared to the more general activities. This was expected, as some customized services are not free (especially for large enterprises) and it is the companies that have to specifically ask for these services, in accordance to their precise needs (a process that requires time and effort).

4.1. Use of innovation broker services

Further on, the companies' use of innovation broker services and their external collaborations will be described according to the control variables presented in the conceptual model. Tables 4.3 – 4.7 show the assessment of the use of Food Valley NL's services and information sources, based on the means and standard deviations of the different categories of respondents as well as of the whole sample. To identify important differences between the means of the groups, the significance coefficient of the ANOVA analysis was considered.

Table 4.3. Use of FV services and external collaboration according to year

		2009			2011			Total			Scale	
		N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Min	Max
Network formation	General**	49	1.67	1.231	49	0.9	0.797	98	1.29	1.103	0	4
	Targeted	49	0.14	0.354	49	0.1	0.306	98	0.12	0.329	0	1
Demand articulation	Market info**	49	0.84	0.514	49	0.55	0.679	98	0.69	0.616	0	2
	Funding**	49	0.43	0.577	49	0.14	0.354	98	0.29	0.497	0	2
Innovation process management	Information**	49	2.35	0.903	49	1.78	1.104	98	2.06	1.044	0	4
	Support	49	0.22	0.468	49	0.14	0.354	98	0.18	0.415	0	1
Internationalization	Participation**	49	0.43	0.612	49	0.18	0.391	98	0.31	0.526	0	2
	Matchmaking**	49	0.22	0.422	49	0.04	0.2	98	0.13	0.341	0	1
External collaboration		49	0.57	0.5	49	0.41	0.497	98	0.49	0.502	0	1

*p<0.1; ** p<0.05

Table 4.4. Use of FV services and external collaboration according FV membership

		Non-members			FVS Members			Total			Scale	
		N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Min	Max
Network formation	General*	17	0.88	0.781	81	1.37	1.145	98	1.29	1.103	0	4
	Targeted	17	0.06	0.243	81	0.14	0.345	98	0.12	0.329	0	1
Demand articulation	Market info**	17	0	0	81	0.84	0.58	98	0.69	0.616	0	2
	Funding	17	0.24	0.437	81	0.3	0.511	98	0.29	0.497	0	2
Innovation process management	Information**	17	1.24	0.97	81	2.23	0.978	98	2.06	1.044	0	4
	Support	17	0.12	0.332	81	0.2	0.431	98	0.18	0.415	0	1
Internationalization	Participation**	17	0.06	0.243	81	0.36	0.555	98	0.31	0.526	0	2
	Matchmaking*	17	0	0	81	0.16	0.369	98	0.13	0.341	0	1
External collaboration**		17	0.24	0.437	81	0.54	0.501	98	0.49	0.502	0	1

*p<0.1; ** p<0.05

Table 4.5. Use of FV services and external collaboration according company size

		SMEs			Large companies			Total			Scale	
		N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Min	Max
Network formation	General	70	1.29	1.144	26	1.27	1.041	96	1.28	1.112	0	4
	Targeted	70	0.11	0.32	26	0.15	0.368	96	0.12	0.332	0	1
Demand articulation	Market info	70	0.71	0.617	26	0.69	0.618	96	0.71	0.614	0	2
	Funding	70	0.29	0.486	26	0.31	0.549	96	0.29	0.501	0	2
Innovation process management	Information	70	2.11	0.986	26	1.92	1.23	96	2.06	1.054	0	4
	Support	70	0.17	0.416	26	0.23	0.43	96	0.19	0.418	0	1
Internationalization	Participation	70	0.31	0.553	26	0.31	0.471	96	0.31	0.529	0	2
	Matchmaking**	70	0.19	0.392	26	0	0	96	0.14	0.344	0	1
External collaboration		70	0.51	0.503	26	0.46	0.508	96	0.5	0.503	0	1

*p<0.1; ** p<0.05

Table 4.6. Use of FV services and external collaboration according company type

		Food processors			Ingredient providers			Technology/knowledge providers			Consultants		
		N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Network formation	General	37	1.35	1.136	11	1.45	1.036	32	1	1.107	16	1.56	1.094
	Targeted	37	0.16	0.374	11	0	0	32	0.19	0.397	16	0	0
Demand articulation	Market info	37	0.7	0.661	11	1	0.632	32	0.75	0.568	16	0.44	0.512
	Funding	37	0.43	0.603	11	0.27	0.467	32	0.22	0.42	16	0.13	0.342
Innovation process management	Information	37	1.81	1.126	11	2.45	0.688	32	2.31	0.931	16	1.88	1.204
	Support**	37	0.35	0.538	11	0	0	32	0.16	0.369	16	0	0
Internationalization	Participation	37	0.19	0.397	11	0.36	0.505	32	0.47	0.671	16	0.25	0.447
	Matchmaking	37	0.05	0.229	11	0.09	0.302	32	0.25	0.44	16	0.13	0.342
External collaboration**		37	0.49	0.507	11	0.82	0.405	32	0.56	0.504	16	0.19	0.403

*p<0.1; ** p<0.05

Table 4.6. (continued)

		Total			Scale	
		N	Mean	Std. Dev.	Min	Max
Network formation	General	96	1.28	1.112	0	4
	Targeted	96	0.12	0.332	0	1
Demand articulation	Market info	96	0.71	0.614	0	2
	Funding	96	0.29	0.501	0	2
Innovation process management	Information	96	2.06	1.054	0	4
	Support**	96	0.19	0.418	0	1
Internationalization	Participation	96	0.31	0.529	0	2
	Matchmaking	96	0.14	0.344	0	1
External collaboration**		96	0.5	0.503	0	1

*p<0.1; ** p<0.05

The results can be described as follows:

- Table 4.3. and Table 4.4. show that the usage rate of all the Food Valley NL's services was higher in 2009 than in 2011 and that FV Society members made more use of these activities, compared to non-members.
- When referring to company size, the only significant differences refer to the International Matchmaking service, that has exclusively been used by SMEs as opposed to large companies and therefore has a higher mean (Table 4.5)
- Considering company type, the specialized support service that underpins the innovation process management broker function (namely Innovation Link) has a higher usage mean for food processors than for knowledge providers, while it can be seen that ingredient providers and consultant firms did not make use of the service (Table 4.6). Ingredient providers show to have the most collaborations with other companies, followed by technology/knowledge providers and food processors.
- The distinction between independent firms and companies that are part of MNC (Table 4.7) shows that only the first used the "International Matchmaking service". This translates into the fact the latter, which are part of larger organizations, were not very interested in finding foreign counterparts for R&D cooperation and development of new projects.

4.2. Realized innovations

The descriptions of realized innovations (product, process, marketing, organizational and total innovations) are presented in tables 4.8 - 4.12. As in the previous section, categorizations according to either FV membership, company size, organization type or company dependence have been used.

Table 4.7. Use of FV services and external collaboration according to company dependence

		Independent companies			Companies part of MNC			Total			Scale	
		N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Min	Max
Network formation	General	58	1.34	1.178	38	1.18	1.01	96	1.28	1.112	0	4
	Targeted	58	0.12	0.329	38	0.13	0.343	96	0.12	0.332	0	1
Demand articulation	Market info	58	0.71	0.593	38	0.71	0.654	96	0.71	0.614	0	2
	Funding	58	0.26	0.442	38	0.34	0.582	96	0.29	0.501	0	2
Innovation process management	Information	58	2.09	0.978	38	2.03	1.174	96	2.06	1.054	0	4
	Support	58	0.16	0.365	38	0.24	0.49	96	0.19	0.418	0	1
Internationalization	Participation	58	0.38	0.587	38	0.21	0.413	96	0.31	0.529	0	2
	Matchmaking**	58	0.22	0.421	38	0	0	96	0.14	0.344	0	1
	External collaboration	58	0.55	0.502	38	0.42	0.5	96	0.5	0.503	0	1

*p<0.1; ** p<0.05

Table 4.8. Innovation performance of companies according to year

	2009			2011			Total			Scale	
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Min	Max
Product innovation	49	0.73	0.446	49	0.67	0.474	98	0.7	0.459	0	1
Process innovation**	49	0.29	0.456	49	0.63	0.487	98	0.46	0.501	0	1
Marketing Innovation	49	0.45	0.503	49	0.61	0.492	98	0.53	0.502	0	1
Organizational Innovation*	49	0.47	0.504	49	0.65	0.481	98	0.56	0.499	0	1
Total Innovation*	49	1.94	1.36	49	2.57	1.791	98	2.26	1.614	0	4

*p<0.1; ** p<0.05

Table 4.9. Innovation performance of companies according to FV membership

	Non-members			FVS Member			Total			Scale	
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Min	Max
Product innovation*	17	0.53	0.514	81	0.74	0.441	98	0.7	0.459	0	1
Process innovation	17	0.41	0.507	81	0.47	0.502	98	0.46	0.501	0	1
Marketing Innovation**	17	0.24	0.437	81	0.59	0.494	98	0.53	0.502	0	1
Organizational Innovation*	17	0.35	0.493	81	0.6	0.492	98	0.56	0.499	0	1
Total Innovation*	17	1.53	1.7	81	2.41	1.563	98	2.26	1.614	0	4

*p<0.1; ** p<0.05

Table 4.10. Innovation performance of companies according to company size

	SMEs			Large companies			Total			Scale	
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Min	Max
Product innovation	70	0.71	0.455	26	0.69	0.471	96	0.71	0.457	0	1
Process innovation	70	0.44	0.5	26	0.5	0.51	96	0.46	0.501	0	1
Marketing Innovation	70	0.57	0.498	26	0.46	0.508	96	0.54	0.501	0	1
Organizational Innovation	70	0.57	0.498	26	0.54	0.508	96	0.56	0.499	0	1
Total Innovation*	70	2.3	1.591	26	2.19	1.698	96	2.27	1.612	0	4

*p<0.1; ** p<0.05

Table 4.11. Innovation performance of companies according to company type

	Food processors			Ingredient providers			Technology/knowledge providers			Consultants		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Product innovation	37	0.7	0.463	11	0.82	0.405	32	0.75	0.44	16	0.56	0.512
Process innovation	37	0.49	0.507	11	0.64	0.505	32	0.47	0.507	16	0.25	0.447
Marketing Innovation*	37	0.57	0.502	11	0.55	0.522	32	0.66	0.483	16	0.25	0.447
Organizational Innovation*	37	0.59	0.498	11	0.82	0.405	32	0.56	0.504	16	0.31	0.479
Total Innovation*	37	2.35	1.654	11	2.82	1.328	32	2.44	1.605	16	1.38	1.5

*p<0.1; ** p<0.05

Table 4.11. (continued)

	N	Total		Scale	
		Mean	Std. Dev.	Min	Max
Product innovation	96	0.71	0.457	0	1
Process innovation	96	0.46	0.501	0	1
Marketing Innovation*	96	0.54	0.501	0	1
Organizational Innovation*	96	0.56	0.499	0	1
Total Innovation*	96	2.27	1.612	0	4

*p<0.1; ** p<0.05

Table 4.12. Innovation performance of companies according to company dependence

	Independent companies			Companies part of MNC			Total			Scale	
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	Min	Max
Product innovation	58	0.72	0.451	38	0.68	0.471	96	0.71	0.457	0	1
Process innovation	58	0.43	0.5	38	0.5	0.507	96	0.46	0.501	0	1
Marketing Innovation*	58	0.57	0.5	38	0.5	0.507	96	0.54	0.501	0	1
Organizational Innovation*	58	0.59	0.497	38	0.53	0.506	96	0.56	0.499	0	1
Total Innovation*	58	2.31	1.592	38	2.21	1.663	96	2.27	1.612	0	4

*p<0.1; ** p<0.05

The results highlight the following:

- The variable “year” has a significant influence when considering organizational and especially process innovations. Table 4.8 shows that answers from 2011 expressed a higher level of these two innovation types during the previous three years, compared to answers from 2009. In the case of process innovation, the 2011 mean is even double than the one for 2009.
- Table 4.9 indicates that FV members admitted to having more product, marketing and organizational innovations. Because of this, the mean for total innovation proved to be much higher.
- When discussing innovation performance according to company size (Table 4.10) an interesting aspect is that, although there is no significant difference between the two years regarding particular innovation types, the total innovation indicator scores slightly higher for SMEs than for large companies.
- Innovation performance, grouped by company type has been presented in table 4.11. The significant differences involve marketing innovation, organizational innovation and total innovation. The responses of technology/knowledge providers show the highest mean when referring to marketing innovation, while food processors and ingredient providers score slightly lower. When talking about organizational innovation, ingredient providers seem to have developed the most new cooperative partnerships, with a mean of 0.82 out of 1.
- The difference between dependent firms and companies part of MNC is small in terms of innovation performance, yet the latter have reported having more marketing and organizational innovations, leading to an increased level of total innovation (Table 4.12).

4.3. Results of probit analysis

In this section the probit analysis results will be discussed. Tables 4.13 shows the way in which different types of innovation broker services as well as company characteristics influence the likelihood of having a higher innovation performance (translated into product, process, marketing and organizational innovations).

- The first innovation broker function reported in literature, **demand articulation**, had no significant effect on any of the four innovation types.
- The services underpinning **network formation** support have similar effect on both product and process innovations. General network formation services such as conferences and innovation seminars seem to negatively influence the likelihood of companies innovating in the two previously mentioned directions while targeted services have a more significant positive correlation. To exemplify, a one unit change in the targeted service variable increases the probability of product innovation by .0956 and the probability of process innovation by 1.242, while a unit change in the general services decreases the chance of product innovation by 0.276 and process innovation by 0.306.
- **Innovation process management** support only influenced the likelihood of having product innovations. The information sources that reflect this function (website, newsletter) have a beneficial effect: a one unit change positively affects the probability of this innovation type by 0.478. By contrast, the targeted service (Innovation Link) is negatively correlated having a coefficient of 0.819.
- **Internationalization** support services also impact product innovation of companies. The services grouped under the variable participation (FV Ambassador program and IFT Food Expo) negatively influenced the likelihood of companies innovating with a coefficient of -0.819 while the “International matchmaking” service has a positive indicated by a coefficient of 2.238. The latter service refers to the specific activities of establishing new businesses and R&D and was therefore expected to have an important positive contribution to innovation performance. By contrast, the other two services have a stronger role in promoting the development of the Dutch Agri-food sector while improving the FV image and secondly in highlighting new business opportunities.
- The **collaboration** variable has a positive effect on all innovation types. In this case, it can be concluded that collaborating with external organizations and therefore performing open innovation stimulates innovation performance, especially when referring to patents and new products.

- **Company type** showed a significant effect only on marketing and organizational innovations. Being a technology/knowledge provider increases the probability of companies reaching new customer segments and market areas by 0.967. Alternatively, ingredient providers are more likely to influence the number of new partnerships by a coefficient of 1.252.
- The **year** variable clearly reflected the innovation trend among actors of the Dutch agri-food industry, in the sense that that 2011 respondents showed an increased likelihood of having process, marketing and organizational innovations in the previous three years.
- As can be seen in Table 4.13 being a Food Valley member increased the chance of companies innovating in term of market areas and customer types (in the previous 3 years) by a coefficient of 1.041.

4.4. Results of ordered probit analysis

The results of the ordered probit regression analysis can be found in Table 4.14. These show the effect of the independent, control and mediating variables on the likelihood of companies having performed total innovation, where total innovation refers to the sum of the four innovation types described in the previous chapters.

From the four innovation broker services, only network formation support and information process management are significant in influencing the probability of having total innovation. The general services that underpin network formation support have a negative influence (0.216 coefficient) while targeted services have a more significant positive contribution (0.879 coefficient).

The information sources underpinning innovation process management support have a significant positive effect on total innovation, a unit change of this variable increasing the total innovation by a coefficient of 0.266.

As seen in the previous subchapter, external collaborations are beneficial for innovation performance. Also, 2011 respondents showed an increased likelihood of having performed total innovation.

Table 4.13 Results of probit regression

		Product innovation			Process innovation			Marketing innovation		
		Coef.	Robust Std. Err.	P> z	Coef.	Robust Std. Err.	P> z	Coef.	Robust Std. Err.	P> z
Network formation	General	-0.276	.166	0.097	-0.306	.176	0.082	-.277	.170	0.103
	Targeted	0.956	.569	0.093	1.242	.466	0.008	.289	.455	0.525
Demand articulation	Market info	.634	.392	0.106	.281	.365	0.441	.036	.320	0.911
	Funding	.315	.406	0.438	.180	.375	0.631	.399	.402	0.322
Innovation process management	Information	0.478	.176	0.007	.149	.167	0.373	.259	.183	0.158
	Support	-0.819	.402	0.041	-.657	.427	0.124	-.184	.346	0.596
Internationalization	Participation	-1.127	.474	0.017	-.052	.331	0.875	-0.942	.318	0.003
	Matchmaking	2.238	.759	0.003	-.241	.471	0.609	.714	.475	0.133
Collaboration		1.062	.376	0.005	0.975	.364	0.007	0.887	.339	0.009
Year		.287	.370	0.438	1.309	.372	0.000	0.952	.339	0.005
Food Valley Society Member (FVS)		-.189	.537	0.725	-.229	.504	0.650	1.040	.594	0.080
Size		.524	.507	0.301	-.177	.492	0.719	-.081	.482	0.867
Company type	Food Processor	.121	.542	0.823	.371	.558	0.506	.807	.524	0.123
	Ingredient provider	-.114	.727	0.876	.738	.569	0.194	.385	.592	0.516
	Technology/ knowledge provider	-.208	.550	0.705	-.961	.518	0.853	0.967	.479	0.043
Company dependence		-.331	.483	0.493	.152	.465	0.705	-.463	.471	0.326

Number of obs = 96
Wald chi2(17) = 40.18
Prob > chi2 = 0.0007
Pseudo R2 = 0.3204

Number of obs = 96
Wald chi2(17) = 36.13
Prob > chi2 = 0.0028
Pseudo R2 = 0.2996

Number of obs = 96
Wald chi2(17) = 38.80
Prob > chi2 = 0.0012
Pseudo R2 = 0.3115

Table 4.13 (continued)

		Organizational innovation		
		Coef.	Robust Std. Err.	P> z
Network formation	General	-.118	.151	0.433
	Targeted	.824	.543	0.129
Demand articulation	Market info	.456	.359	0.205
	Funding	-.351	.392	0.371
Innovation process management	Information	.214	.173	0.215
	Support	.254	.355	0.475
Internationalization	Participation	.110	.345	0.749
	Matchmaking	.578	.550	0.293
Collaboration		.544	.304	0.073
Year		1.076	.373	0.004
Food Valley Society Member (FVS)		.081	.489	0.869
Size		-.086	.468	0.854
Company type	Food Processor	.696	.503	0.167
	Ingredient provider	1.252	.596	0.036
	Technology/ knowledge provider	.277	.449	0.537
Company dependence		-.236	.420	0.574

Number of obs = 96
Wald chi2(17) = 30.83
Prob > chi2 = 0.0141
Pseudo R2 = 0.2438

Table 4.14 Results of ordered probit regression

		Total innovation		
		Coef.	Robust Std. Err.	P> z
Network formation	General	-.216	.114	0.058
	Targeted	.880	.365	0.016
Demand articulation	Market info	.302	.271	0.266
	Funding	.052	.279	0.851
Innovation process management	Information	.266	.154	0.084
	Support	-.273	.276	0.323
Internationalization	Participation	-.395	.243	0.103
	Matchmaking	.471	.330	0.152
Collaboration		.802	.274	0.003
Year		.866	.296	0.003
Food Valley Society Member (FVS)		.227	.513	0.658
Size		-.014	.369	0.969
Company type	Food Processor	.473	.442	0.285
	Ingredient provider	.573	.447	0.200
	Technology/ knowledge provider	.283	.395	0.747
Company dependence		-.105	.357	0.770

Number of obs = 96
Wald chi2(17) = 57.46
Prob > chi2 = 0.0000
Pseudo R2 = 0.1456

5. Conclusions

This chapter will present the conclusions of the research. The first conclusions will concern the research as a whole, while the ones that follow regard the hypothesis formulated in the section 2.4 as well as the main research question.

5.1. Conclusions on research methodology

When compared to most of the previous studies, this research has several particularities. The first is that it focuses on the effect of the services provided by a single innovation broker. Secondly, the data used comes from two different years, therefore some additional information was extracted based on this characteristic.

Using a single innovation broker for the case study has some limitations concerning the validity of the results for innovation brokers in general. The responses are diverse enough to describe the activity of Food Valley NL, but because this innovation broker is mostly regionally focused, it is impossible to refer to innovation brokers in general.

Having data from two different years allowed a limited comparison regarding the outcome of Food Valley NL broker functions and gave insight into the effect that these had over time. It was interesting to see higher levels of reported service use in 2009 and also better innovation performance within the years 2009-2011. This suggested that FV services were in deed effective in promoting innovation among users.

5.2. Answering the research question and hypothesis testing

The main research question of this study was:

“How do different services provided by an innovation broker impact the innovation performance of companies that make use of them?”

In order to aid the task of finding an answer, this question was divided into four composing sub-questions. Based on the results showed in the section 4, each sub question will be stated and answered as follows:

SQ1: How do network formation support services impact the innovation performance of companies that make use of them?

Network formation support services are meant to facilitate linkages between industry actors and also to close the information gap of the system. The more general services offered by FV such as the FV Conference and the Open Innovation seminars seem to have a negative influence on product and process innovations, while the targeted service that focuses on finding innovation partners, positively influences these innovation types. An explanation can be that the general activities are efficient in bridging cognitive and cultural differences between knowledge domains and in providing companies with access to system information but reduce the time companies allocate to complete product and process innovations, while the specialized service focuses connecting specific actors together to help them obtain such innovations and is therefore, more closely linked to the innovation output.
the innovation process.

SQ2: How do demand articulation support services impact the innovation performance of companies that make use of them?

According to literature, the function “demand articulation” is very important in promoting the innovation needs of companies, needs that refer to knowledge, technology, policy and funding. The results show that the services that FV offers in relation to this function, namely Market Intelligence trend reports, Tailor-made Market Intelligence service and the funding service called “Applying for Subsidies” have been mostly used in 2009, the users typically being FVS members.

Nevertheless, these services show no significant influence on the innovation performance of companies. This translates into the fact that although getting access to knowledge about the market might be an important step in the innovation process, it does not lead directly to company innovation.

SQ3: How do innovation process management support services impact the innovation performance of companies that make use of them?

Innovation process management helps align the actors from different institutional backgrounds and with different norms, values, incentive and reward systems within the network.

In the case of Food Valley, innovation process management was reflected by information sources such as website and newsletter as well as an actual support service entitled Innovation Link. The reported usage of the information sources proved to be higher in 2009 and among FVS members, significantly influencing the positive likelihood of having product innovation. This concludes that such communication tools are useful for companies.

SQ4: How do internationalization support services impact the innovation performance of companies that make use of them?

Internationalization services facilitate international linkages between organizations, leading to broader exposure and intensified technological change.

The International Matchmaking service appears to be effective in this direction, positively influencing the probability of companies innovating in terms of patents and products. On the other hand, similar to the general network formation services, IFT Food Expo and the FV Ambassador program appear to have negative influences, probably also due to their more general character, focused on promoting the development of the Dutch Agri-food sector and the FV image.

Summing up the responses given for each sub question, it can be concluded that in the case of Food Valley, some services (targeted network formation support, information sources that underpin innovation process management and international matchmaking services) do have a beneficial effect on the likelihood of companies realizing innovations while others show to be negatively correlated to such outcomes (network formation general services, Innovation process management targeted service called innovation link, IFT Food Expo and FV Ambassador program).

Hypothesis testing

As presented in chapter 2.4, the hypothesis was: “Services underpinning network formation support have the strongest positive influence on company innovativeness compared to other innovation broker services”. Results of the ordered probit regression analysis showed that this is only half true, namely for the targeted services that underpin network formation support, which did have the highest significance level and correlation coefficient from all the innovation services (Table 4.14). Yet, because general network formation services (conferences, open innovation seminars) were also part of the function and these showed a negative correlation, the hypothesis was rejected.

5.3. Conclusions on the other elements of the conceptual model

Referring to the control variables from the conceptual model, only company type showed significant influences on innovation performance.

Technology/knowledge providers positively influence the likelihood of companies innovating in terms of customer types and market areas, whereas ingredient providers increase the chances of organizational innovation

6. Recommendations

I would like to end my thesis with a few recommendations, for both Food Valley Organization and further research in the field of innovation brokers.

Based on the data analysed for this research, the use of FV services and activities could be characterized as rather low (see Table 4.2). In this sense, the organization should take advantage of the well-read newsletter and website for more intense promotion and also explore other communication channels for reaching new companies. Also, better insight is needed in understanding the reasons for which companies do not use the services (there might be other justifications apart from lack of awareness). This information could serve as further input for improving the facilities. Maintaining the quality of the specialized services such as **Finding partners to innovate** and **International matchmaking** is essential, as these seem to have the highest value.

In addition to the three most common IB functions reported in literature, namely network formation, demand articulation, innovation process management this research also included internationalization. It would be interesting to gain further insight into how this specific function connects to the open innovation process, taking into account globalization and industry trends.

For future research, a company perspective might be useful for other innovation brokers who want to assess the relevance of their activities. More exploration is needed, preferably from a qualitative angle. Closed inquiries do not seem effective enough in capturing the reasoning behind service use/non-use as well as the link between the broker activity and the exact contribution to the companies' performance. One suggestion here would be to perform qualitative interviews using the laddering technique.

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Appendix 1

Mapping of services and activities offered by Food Valley NL

Product	Type	Description	Products	Specific function	IB Function
FV Conference	Activity	<ul style="list-style-type: none"> - broad practical program of lectures and interactive workshops - good opportunity to view and/or sample new products - workshops give special and useful information concerning the theme of the conference for the business success of the participants 	Networking	Networking (internal)	Network formation
			Presentation of companies	Support to the region activities	
			Database of participants to the annual conference	Collecting information	
			Report of the conference	Evaluation of FV activities	
			Improve FV image	Improve FV image	
			Lectures	Knowledge transfer	
			Workshops	Knowledge transfer	
			Presentation of new ideas	Entrepreneurial development	
FV Open Innovation Seminars	Activity	<ul style="list-style-type: none"> - Thematic innovation meetings that are organized on a regular basis, often in close cooperation with other parties; examples of themes: nanotechnology, packaging, ICT applications in food, functional foods in Japan and human capital 	In document: FV Innovation Insights	Access to information of the system	Network formation
			Possibilities to improve innovation competences and capabilities of participants	Innovation stimulation	
			Workshops of possible new projects	Influence in direction of new developments	
			Knowledge transfer in innovation	Knowledge transfer	
FV Society Meetings (members only)	Activity	<ul style="list-style-type: none"> - hosted by one of the member companies, which benefits from an excellent opportunity to showcase its own business - always deal with a particular theme, which means that members jointly select topical themes to put on the agenda - outstanding opportunity to network and initiate closer cooperation 	Showcase of a member of FVS	Support to region activities	Network formation
			New collaboration activities	Promote collaboration	
Food Valley Award	Activity	<ul style="list-style-type: none"> - award for the most distinctive project or initiative in the food or food-related industry, for companies that have set themselves apart in terms of innovativeness, partnership and 	Report of the jury	Collecting information	Innovation process management

		Corporate Social Responsibility - is given in an open context, where any food related company or institution can participate - three finalists are selected by the jury, these are presented during the FV Conference and the visitors have to choose from the three.	Evaluation of the innovations presented by the visitants	Collecting information	
			List of "innovation"	Collecting information	
			Presentations of the best new ideas/companies	Innovation stimulation	
FV Market Intelligence Tailor-Made Market Intelligence	Service	- Up to 2011 Food Valley had access to the Innova Market Insights database containing data on innovations, trends and other relevant food industry developments around the globe. - product development support and marketing support	Access to market information	Access to market information	Demand articulation
			Support to develop strategies in marketing	Support to SMEs	
FV Market Intelligence Trend Reports	Information	- reviews based on retrieved data from the Innova Database that give an overview of trends and developments in areas such as Dairy Drinks, Ready-made meals or one of the other 36 available categories	Access to market information	Access to market information	Demand articulation
FV Innovation Link	Service	- platform that gives SMEs the opportunity to have rapid access to technological advice and expertise they need - staff members act as "Lighthouse keepers" processing the SMEs queries and locating the person with the right expertise in the network; in less than a week the SME will receive a standardized report with an overview with of who can give additional assistance and what they can do. - meetings between the experts and SME's to stimulate innovation and creativity Objective: - make a bridge between SME's and knowledge creation organizations - stimulate innovation and creativity	Collaboration between SMEs and Research Institutes	Promote collaboration	Innovation process management
			Access to specialized knowledge	Access to knowledge	
			Easier access to knowledge for the SMEs	Support to SME	
			Meeting for creativity	Innovation stimulation	
FV Ambassador Program	Service	- project that offers one year internships to international students in Dutch companies and research organizations in the food knowledge cluster; in addition they will be trained in communication, knowledge of international networking and marketing	Ambassador of FV in other countries	Improve FV image	Internationalization
			Companies with international Human Resource	Access to human resources	

		<ul style="list-style-type: none"> - aims to promote FV as the knowledge region for food & nutrition in Europe and to support international high potential having almost finished their Master of Science in food technology - establishes a long term relationship with the students through a network of ambassadors 	Support to extra training for international students	Professional student development	
			Database of ambassador	Evaluation of FV activities	
			Establishment of collaboration between ambassadors	Networking (internal)	
IFT Food Expo	Activity	<ul style="list-style-type: none"> - FV coordinates the participants of the Dutch Agri-Food sector in the IFT conference in USA - Companies, R&D institutes present an image of the Dutch Agri-food sector in order to attract new investments in the Netherlands and to define new options of collaboration - define new business markets for the participants 	New business opportunities for participants	Support to region activities	Internationalization
			Possibility for establishing new companies in FV	New activities in the region	
			Presentation of the Dutch Agri-food	Promote the development of the Dutch Agri-food sector	
FV International Matchmaking	Service	<ul style="list-style-type: none"> - the main goal is to put FV companies and institutes in contact with foreign counterparts for R&D cooperation and development of new projects as well as to facilitate the whole process for establishing a company in the FV Region 	Establishment of R&D contracts	New activities in the region	Internationalization
			Establishment of new business	Entrepreneurial development	
			Matchmaking	Promote external collaboration	
Assistance in Applying for Subsidies	Service	<ul style="list-style-type: none"> - Management and development of European projects in order to improve the economic performance of the provinces of Gelderland and Overijssel. Most projects are co-financed by European Funds. - Coaching (local and regional) authorities and industries to make good projects to co-finance with regional European Funds and also teach them how to monitor the projects - Bring companies in contact with capital investors 	New projects in the region	Support to SMEs	Demand articulation
			Provide access to financial resources	Access to capital	
Finding Partners in	Service	- Facilitating innovation cooperation between FV	Network innovation	Networking (internal)	Network formation

Innovation		Society members			
Food Valley Newsletter	Information	- The FV Society alerts its members of interesting conferences, news and developments; members are asked to take part in national and international programs, or join other members at an international trade fair	Newsletter	Knowledge transfer	Innovation process management
FV Website	Information	- portal presenting news, stories about developments in the food industry, relevant results from science and technology, activities and events occurring in the sector and in Food Valley Region	Channel of communication	Access to information of the system	Innovation process management
			Knowledge sharing	Knowledge transfer	
FV Market Insights Publications (for members only)	Information	Using the information in the Innovation database, a trend report about the Market trend in the food industry is made and sent to members for possible new developments. The process continues with making the needed connections between the members to develop the project. This information will be used as a based to define the topics of the innovation meetings.	Market information for FVS members	Access to market information	Demand articulation
			Definition of need for the innovation meetings	Identification of needs	
			Report of possible uses of the information for new developments	Innovation stimulation	