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The Influence of Networking and Absorptive Capacity on the Innovativeness of Farmers in the Dutch Pork Sector

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Abstract

The main objective of this study is to answer the question of how farmers' networking behaviour and their ability to acquire, assimilate, transform and exploit external knowledge is related to their level of innovativeness and profitability. These relations were tested on the basis of structural equation modeling using 444 questionnaires completed by large-scale pig farmers in the Netherlands. Previous studies on the relation between network structure and innovativeness retained the absorptive capacity 'black box' by using proxies for absorption of knowledge. The present study addresses this shortcoming by studying absorptive capacity in terms of organizational capacities (routines and processes) of farmers to use their networks and absorb external knowledge. The findings show that frequency of contact in a specific network range affects innovativeness positively, but also indirectly through acquisition and assimilation capacity. Assimilation capacity turns out to be the most important dimension of absorptive capacity for the innovativeness of pig farmers.

Keywords: absorptive capacity, networking, pig farmers, innovativeness

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Introduction

In the last decade the Dutch pork sector experienced about a 50% reduction in the number of farms, while the number of pigs per farm almost doubled (LEI and CBS 2011). Such efficiency leaps are part of the reason the Netherlands is able to continue to play an important role in the European pork sector. However, because of increased competition in the sector, the price per kilo pork paid to the farmer is decreasing, which is leading to a continuous drive for the farmers to lower their costs and increase efficiency further. At the same time, the gains in efficiency were often accompanied by compromises in fields such as the environment and animal welfare. Increased societal pressure to invest more in animal welfare and reduce the environmental burden, as well as the economic and market situation in Europe and beyond, has put pressure on the pig farmer to place more emphasis on innovativeness and creativeness. Pig farmers need sufficient innovation capability to retain their competitive advantage and assure survival (Li and Calantone 2002). Although financial capacity is very important, the ability to change and innovate is also dependent on the ability to recognize, understand and apply new developments and technologies. For the purpose of increasing the innovative capacity of farmers, collaboration with different actors is important (Klerkx and Leeuwis 2009), such as knowledge-intensive institutes, universities and technology developers, but also butcheries or supermarkets that can contribute to new product concepts. In this regards it is important to establish how the farmers' networking behaviour and capacity to 'absorb' information relate to innovativeness, in order to determine how farmers can use their network to improve their innovative capacity.

On the basis of previous research it is known that strong ties and network cohesion are important for the transfer of especially complex and tacit knowledge (Coleman 1988; Krackhardt 1992), but that weak ties and structural holes which bridge organizational boundaries are important for the acquisition of diverse, new knowledge, leading to innovation and innovativeness (Burt 1992, 2005; Rosenkopf and Nerkar 2001). Reagans and McEvily (2003) advanced this discussion by establishing that network cohesion (overlapping ties among mutual third parties) and network range (relationships that span multiple knowledge pools) need not come at the expense of each other, but approach an optimal network structure which combines elements of both (Burt 2000; Reagans and Zuckerman 2001; Reagans, Zuckerman and McEvily 2003). With the assumption that knowledge absorption takes place in the presence of overlap in knowledge, Reagans and McEvily (2003) conclude that a strong tie across a structural hole eases knowledge transfer. More importantly, they conclude that an individual surrounded by a diverse network could transfer knowledge across a structural hole even in the case of a weak connection. This indicates that capacities to absorb and transfer knowledge are built through maintenance of a diversity of network ties. Reagans and McEvily (2003) take into account control variables, which are supposed to explain the variance which can be attributed to absorptive capacity differences among individuals. However, as Reagans and McEvily (2003) mention, they did not assess the absorptive capacity or measure individual behaviour directly.

The present paper contributes to existing literature by focusing on the behavioural aspect in terms of organizational capacity to access, assimilate, transform and exploit knowledge (Zahra and George 2002; Volberda et al. 2010), instead of using proxies for absorptive capacity, such as the overlap in the knowledge base of the interacting actors (Zaheer and Bell 2005; Van Gilsing and Nooteboom 2008; Nooteboom et al. 2007). As Lewin et al. (2011) argue, although absorp-

tive capacity is a widely used concept, the organizational routines and processes that constitute absorptive capacity remain a 'black box' (e.g., Lane et al. 2001; Zahra and George 2002; Lewin and Massini 2003; Todorova and Durisin 2007; Lane et al. 2006). The studies which look at the relation between network structure and innovativeness retain this black box by using proxies for studying the effect of absorptive capacity in this relation. In the present paper, we address this shortcoming by studying the relationship between networking behaviour and absorptive capacity, by focusing specifically on the organizational capacities (routines and processes) of farmers to use their networks and absorb external knowledge.

In addition, the relations among the different dimensions of absorptive capacity are tested to find out whether the previous model, which posits sequential relations from recognition and assimilation to transformation and exploitation (Zahra and George 2002; Volberda et al. 2010), also holds in the case of innovation by pig farmers. The absorptive capacity of larger farmers, who could engage in large-scale innovations with sustainability-oriented goals and increase their level of innovativeness, is left unexplored. The question addressed in this paper is how the farmers' networking behaviour and their ability to acquire, assimilate, transform and exploit the external information and knowledge is related to their level of innovativeness and profitability. This question addresses the theoretical issue of behavioural aspects of networking and absorptive capacity, as well as the practical issue of how networking can enhance the innovative capacity and profitability of pig farmers.

Section 2 of the present paper provides an overview of the theoretical background of the conceptual framework. It addresses definitions and previous research about innovativeness and absorptive capacity. In the third section, previous research about the relation between networking and absorptive capacity is addressed. The conceptual framework and hypotheses concerning the relationship between networking frequency, absorptive capacity, innovativeness and profitability are introduced. In section 4, the method of data collection, the measurements, as well as the structural equation modelling as the method of analysis are introduced. In section 5, the results are discussed on the basis of the model and the tested hypotheses. Also, differences in specific pig farmers' networking behaviour, i.e. between farmers with high and low absorptive capacity and a high and low level of innovativeness, are discussed. In section 6, the conclusions and discussions are presented, includiing sector implications based on a reflection on the sector.

Theoretical Background

Innovativeness

Innovativeness and the ability to introduce innovations is regarded as one of the most important aspects of the entrepreneurial process and is considered one of the dimensions of entrepreneurial orientation (Lumpkin and Dess 1996; Schumpeter 1934). Innovativeness reflects a firm's tendency to engage in and support new ideas, novelty, experimentation and creative processes that may result in new products, services or technological processes (Lumpkin and Dess 1996; Rhee et al. 2010). Although innovations can vary in their degree of radicalness (Hage 1980), innovativeness represents a basic willingness to depart from existing technologies or practices and act beyond the current state of the art (Kimberly 1981). When it comes to psychometric properties for measurement of innovativeness (Pallister et al. 1998), it may be relevant to establish the tendency and willingness to change. However, in the effort of establishing the extent to which capacities to

absorb knowledge are present in a company, it may be more useful to determine innovativeness more rigorously by looking at the extent of adoption of innovation. This means that not only the willingness to change, but also the degree to which an innovation is adopted earlier than by others (Rogers 2003) is a reflection of the extent of innovativeness. Accordingly, in the present paper, not only the organization's willingness to change, but also the rate of adoption of innovations by the firm (Hurt et al. 1977, 2004; Calantone et al. 2002) is considered as a reflection of innovativeness.

Absorptive Capacity

For the purpose of raising the level of innovativeness, previous research emphasized the importance of learning (Cohen and Levinthal 1990) and the role of networks in creating access to knowledge, thereby facilitating the learning process (Tsai 2001; Oliver 2001; Lane and Lubatkin 1998; Ahuja 2000; Ahuja and Katila 2004). In their seminal paper, Cohen and Levinthal (1990) point to the importance of the firm's capabilities to assimilate and exploit information in generating innovations (Cohen and Levinthal 1989). Cohen and Levinthal contributed to the existing literature by introducing a set of industrial-organization (IO) economics-based explanations of a firm's absorptive capacity. They argued that if the costs of acquiring external knowledge are small at the time of learning, it is because the firm has already invested in the development of the ability to identify, assimilate and exploit knowledge from the environment, which is called the firm's learning or absorptive capacity (Cohen and Levinthal 1989, 569).

Knowledge has a central position in the literature which deals with absorptive capacity. Knowledge is posited as one of the most important resources of the firm; and prior knowledge is especially important for the ability to accumulate new relevant knowledge and learn from other internal or external resources of knowledge. Increased learning in a particular area enhances the organization's knowledge base in that area, which further increases its absorptive capacity and thus facilitates more learning in that domain (Autio et al. 2000; Barkema and Vermeulen 1998). It is argued that a balance of knowledge similarity and dissimilarity (usually operationalized as complementary resources or capabilities) has been associated with positive alliance outcomes, such as innovation (Ahuja and Katila 2001; Dyer and Singh 1998; Jones et al. 2001; Lane and Lubatkin 1998; Larsson et al. 1998; Shenkar and Li 1999; Simonin 1999). The argument is that absorptive capacity, in terms of the knowledge base and familiarity with new knowledge, results in assimilation of new knowledge (Lane et al. 2006). Besides the importance of the knowledge base and knowledge overlap for absorption of new knowledge, also the intensity of effort (Kim and Lee 2002), embeddedness in knowledge networks (Oliver 2001) and internal integration (Meeus et al. 2001) facilitate organizational learning.

Zahra and George (2002) contributed to the organizational learning capabilities field by introducing a dynamic capabilities perspective of absorptive capacity in terms of four complementary dimensions. They argue that acquisition and assimilation of new external knowledge enable firms to continuously improve, renew and increase their knowledge stocks. In order to complement these long-term pay-offs, firms should also engage in sufficient transformation and exploitation. It is argued that firms' adoption of innovation and willingness to change depends on them effectively developing internal knowledge, utilizing external knowledge and exploiting knowledge to generate innovations (Kogut and Zander 1992; Teece 1996). Firms' ability to as-

similate and exploit external knowledge is related to their use of knowledge in the search for innovation. Cohen and Levinthal (1989, 1990) defined absorptive capacity as a firm's ability to recognize the value of new external knowledge, assimilate it and apply it to commercial ends. Given the greater availability of external knowledge sources in modern economies, a dynamic capability that influences a firm's ability to target, absorb and deploy the external knowledge necessary to feed the internal innovation process becomes a crucial source of competitive advantage (Fosfuri and Tribó 2008). Todorova and Durisin (2007) also point to the capabilities necessary to recognize the value of external information for transformative processes, and regimes of appropriability. Lane et al. (2006) emphasize the dynamic nature of absorptive capacity by pointing to exploratory, transformative and exploitative learning. According to Lane et al. (2006), one of the major shortcomings of the existing absorptive capacity literature is the lack of attention given to the processes underlying absorptive capacity. Most empirical studies refer to R&D (e.g. Veugelers 1997; Rocha 1999; Stock et al. 2001; Tsai 2001), patents (Mowery et al. 1996) or co-authored papers as proxies for absorptive capacity. These indirect measures capture only partially the aspects of capabilities related to valuing new, external information, its assimilation, and its application to commercial ends. There is a lack of direct observation or measurement of the routines that constitute absorptive capacity (Lewin et al. 2011).

In the present study, the view is taken that organizational and combinative capabilities of the firm are important for its access to information and knowledge from external sources and for the ability of the firm to understand and learn from the new information and knowledge. One of the absorptive capacity organizational capabilities is reflected by acquisition, which refers to a firm's capability to identify and acquire externally generated knowledge that is critical to its operations (Zahra and George 2002). The intensity and speed of a firm's efforts to identify and gather knowledge can determine the quality of a firm's acquisitions (Kim 1997a,b). The second organizational capability of the firm is related to its ability to understand and learn from the new information and knowledge. Assimilation capacity refers to the firm's routines and processes that allow it to analyse, process, interpret and understand the information obtained from external sources (Kim 1997a,b; Szulanski 1996). The third combinative capability which is important for the enhancement of innovativeness is transformation capacity. This denotes a firm's capability to develop and refine the routines that facilitate the combining of existing knowledge with the newly acquired and assimilated knowledge. This is accomplished by adding or deleting knowledge or simply by interpreting the same knowledge in a different manner. The ability of firms to recognize two apparently incongruous sets of information and combine these into an innovation reflects their transformation capability. The ability to transform new knowledge is important for reframing of the firm's definition of the industry and competitive strategy (e.g. Christensen et al. 1998). The fourth combinative capability contributes to the innovative output of the firm. Exploitation capacity reflects the routines of the firm to refine, extend and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations. Exploitation reflects a firm's ability to harvest and incorporate knowledge into its operations (Tiemessen et al. 1997; Van den Bosch et al. 1999). It requires retrieval of knowledge that has already been created and internalized for use (Lyles and Schwenk 1992). The outcomes of systematic exploitation are the persistent creation of new goods, systems, processes, knowledge or new organizational forms (Spender 1996).

Previous Research and Hypotheses

Networking, Absorptive Capacity and Innovativeness

The relationship between network structure and absorptive capacity has been addressed by previous studies (Tsai 2001; Van Gilsing et al. 2008), but without reference to the organization of networking behaviour. In the present study, social network literature is used to hypothesize on the organization of networking behaviour and its relation with absorption of external knowledge. In a study about networking behaviour of hospitals, it was established by Goes and Park (1997) that the type and degree of ties affect the ability of the firm to integrate and assimilate external knowledge. Frequency of contact, as one of the indicators of strong ties (Granovetter 1982; Krackhardt 1992), is considered an important relational trait, which enables transfer of especially *complex knowledge* and information entailed in innovation (Hansen 1999; Reagans and McEvily 2003; Krackhardt 1992; Uzzi 1997; Van Gilsing and Nooteboom 2005; Nooteboom et al. 2007). At the same time, a wide network range (Reagans and McEvily 2003) is important to gain new external knowledge. An individual with a widespread network of connections across multiple pools of knowledge and expertise bridges holes between people and is exposed to more diverse knowledge (Reagans and McEvily 2003).

For the pig farmers, interaction with different types of actors may be important for accumulation of relevant information and knowledge to realize different types of innovations. Knowledge-intensive institutes, such as universities or innovation centres, may be important because they aim at improving pork production and pork chain organization in the longer term. Technology developers provide new housing concepts, technology for reducing emissions or improvement of animal welfare. For the absorption of knowledge about wishes and requirements from society, exchanges with animal welfare and environmental organizations may be useful. Also, chain actors may make important contributions to the farmers' level of innovativeness. For example, transport companies can influence perceptions of the farmers' innovativeness by means of their advanced, innovative or animal-friendly transportation methods (Wognum et al. 2007).

Reagans and McEvily (2003) conclude that an individual surrounded by a diverse network could transfer knowledge across a structural hole, even when the connection is weak. Apparently, transferring knowledge and maintaining a diverse network are related, as experience with one of the two helps to achieve the other. Farmers engaged in more frequent networking with a wider range of knowledge sources are more likely to experience a rich exchange of knowledge and in this way be more skilled in approaching specific actors for acquisition of the knowledge that they need. Frequency of interaction and information exchange increases the amount of information the farmers accumulate, which contributes to a better ability to identify and understand the pieces of knowledge that are relevant for their own farms and innovations. As the higher level of interaction increases the likelihood of (tacit) knowledge transfer and assimilation (Dhanaraj et al. 2004), it is expected that:

H1a: *Networking frequency of pig farmers is positively related to their acquisition capacity*.
H1b: *Networking frequency of pig farmers is positively related to their assimilation capacity*.

Acquisition capacity of the farmers can be reflected by more skill in collecting knowledge about developments in the sector through discussions with business partners, and through participation

in seminars or conferences. More frequent interaction enlarges the pool of knowledge they acquire and helps them to increase their insight about developments, innovations and their implications. This is expected to contribute to an increase in their ability to recognize changes in rules and regulations, shifts in market competition and new possibilities to serve their clients and customers. Through the time they allocate and skills they develop to establish contact with actors in the chain and network, which can provide them with the relevant knowledge, it is expected that the capacity of these farmers to analyse, process, interpret and understand external changes and developments is positively affected. Therefore, farmers' acquisition capacity is expected to be positively related to their assimilation capacity.

H2: *Pig farmers' acquisition capacity is positively related to their assimilation capacity.*

Furthermore, farmers who are more skilled in the recognition of changes in technical possibilities, and who are always among the first to detect changes in rules and regulations and changes in market competition are considered to have a better ability to analyse, process, interpret and understand external knowledge and information (assimilation capacity). Farmers with higher assimilation capacity are also expected to be more skilful in assessing the relevancy of new information and knowledge for their own farms. Greater ability to understand new possibilities and opportunities is expected to result in more skill in recognizing the usefulness of new and external knowledge for innovations on their own farms and a greater capacity to translate new information and knowledge into changes, adaptations or innovations. Accordingly, it is hypothesized:

H3: *Pig farmers' assimilation capacity is positively related to their transformation capacity.*

It is expected that the capacity to transform and apply knowledge to one's own farm is positively related to exploitation capacity. Skill in assessing the relevancy and usability of new information for innovation on one's own farm, plus the capacity and ability to translate market trends into adaptations on the farm, is expected to result in the ability to make an additional step. The latter is related to exploitation of the innovation. Farmers with high transformation capacity are expected to be more skilful in transposing the information into profitable changes and adaptations on the farm. Farmers who translate new knowledge into actual adaptations usually also have an idea about how the adaptation will contribute to increased profit. Therefore, it is expected that:

H4a: *Pig farmers' transformation capacity is positively related to exploitation capacity.*

The transformation capacity of farmers in the pork sector consists, for example, of the ability to combine external knowledge about the changes in the market with their internal knowledge to make changes to their feed systems, business models or stable (hardware) arrangements. It is also demonstrated by their approach to saving knowledge for later use, and their resources and skills to build on existing knowledge and translate it into adaptations to their businesses. For example, a farmer who is used to regularly discussing changes and trends in the market with advisors or personnel is more trained to regard and understand the same knowledge in a different manner, acquire new insights, recognize new opportunities and adapt the image of his or her own farm and those of competitors. This ability to transform external knowledge into useful applications indicates that the farmer has a greater insight into the possibilities of new developments and technologies. This greater insight is expected to be positively related to adoption of (People, Planet, Profit and Pigs) innovations. Accordingly, it is expected in the present study that:

H4b: *Pig farmers' transformation capacity is positively related to innovativeness.*

Farmers who require little effort to implement new processes on their farms are expected to have a more systematic ability to exploit external knowledge by incorporating it into their own operations. Those farmers who are more proficient in converting external knowledge into profitable applications on their own farms are expected to increase their profitability. Higher profitability due to implementation of new systems, processes and organizational forms is a reflection of a higher capability to exploit external knowledge. The ability of these farmers, not only to introduce an innovative application or adaptation into their own company, but also to ensure that the gains of the change exceed the costs leads to the expectation that:

H5a: *Pig farmers' exploitation capacity is positively related to profitability.*

Innovations in the pork sector introduced by farmers are usually process and organization-related innovations. These are characterized by a higher level of adoption of technological, managerial and organizational innovations. In the present study, innovativeness is interpreted as the level of investment in new (technological) possibilities or (hardware) improvements in the stables. Within this concept, pig farming systems are developed to cover the needs of the animal, the environment, the farmer and the citizen-consumer. Innovative farmers who are able to combine these four objectives are expected to be more profitable. A high level of innovativeness is required to assure low costs, a speedy production process and/or a low amount of labour per pig, while at the same time assuring animal-friendly treatment of pigs and processes which reduce the burden on the environment (Li and Calantone 1998). Reducing costs and raising value by offering products which result from an animal and environment-friendly production process is expected to result in higher profitability for the farmer. Accordingly, it is expected that:

H5b: *Pig farmers' innovativeness is positively related to profitability.*

The hypotheses above are captured in the following Figure 1. This conceptual model will be used to analyse the relations between networking and absorptive capacity with innovativeness and profitability among the pig farmers.

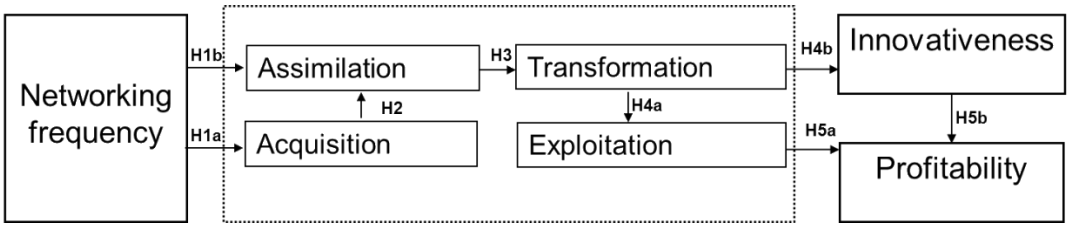

Figure 1. Conceptual Model

Methods and Data

In 2010, the Netherlands produced around 24.9 million pigs at about 7,000 farms (PVE 2011a). About 1.0 million pigs were imported and 11.3 million were exported. The meat export was three times the volume of the meat import (PVE 2011b). Germany, Italy and the United Kingdom are important export countries. The competitive position of the pork sector in the Netherlands is

largely based on its increasing efficiency levels (Hoste 2011). In the last decade the sector experienced about a 50% reduction in the number of farms, while the number of pigs per farm almost doubled (LEI and CBS 2011). At the same time, the efficiency gains were often accompanied by compromises in factors such as the environment and animal welfare. The increasing attention of policy makers and society to environmental problems and animal welfare concerns resulted in adjustments to legislation, requiring different measures and investments by farmers to reduce food-safety-related risks, mineral output and ammonia emissions, and to improve animal welfare. The Dutch government adopted new regulations with regard to animal welfare[1] and the environment[2] which will go into effect by the year 2013 (Baltussen et al. 2010). These require, for example, that all pregnant sows be accommodated in group housing (in line with European legislation), fattening pigs have more space, and that ammonia emissions and the use of antibiotics is reduced. These changes put strains on farmers, some of whom will not invest in the adaptations required by the stricter regulations (Baltussen et al. 2010). Financial capacity[3] is among the main reasons that these farmers experience difficulty to fulfill the animal welfare and environment criteria, but practical problems have also been encountered.

For the purpose of increasing the innovative capacity of farmers, information exchange and collaboration with different chain and network actors are important (Klerkx and Leeuwis 2009). Simply studying the interaction with different kinds of actors does not provide sufficient information as to whether the farmers are using and assimilating the acquired information from the network. Therefore, the absorptive capacity of farmers must also be studied directly. The ability to change and innovate is also dependent on the ability to recognize, understand and apply developments, new techniques and technologies within one's own company. The fact that the farmers in the pork sector are increasingly pressured to place emphasis on innovation, through learning and integration of innovative ideas and knowledge from the external environment, makes this sector an appropriate field of study to find out how networking behaviour and absorptive capacity relate to innovativeness and profitability.

Sample

For the present study, 1657 medium- to large-size farms were selected because they represent the largest group of pig farmers in the Netherlands and provide most insight into how animal welfare and environment-friendly (4P) innovations can be applied on a larger scale. The selection criterion for the 1657 farms was that the farm would count 300 or more sows and/or 1500 or more fattening pigs. Farms with at least 300 sows cover 73% of the sows in the Netherlands; and farms with at least 1500 fattening pigs cover 62% of the fattening pigs in the Netherlands. About one third of the pig farms have both sows and fattening pig (CBS 2011).

A large-scale survey was administered to these farmers by post. A return envelope was enclosed to enable the farmer to send back the completed questionnaire. The response rate was 27. 9% or 462 responses. The analysis was performed based on completed questionnaires from 444 farms, after deletion of unusable cases. Of these 444 farms, 407 had sows and 402 had fattening pigs.

[1] The Pig Decree
[2] The Ammoniac Emission Decree for Housing
[3] In 2008, 56% of the pig farms had a good to reasonable financial position and 13% of the farms ran a great risk of having to stop for financial reasons. The remaining 31% of the farms could continue to produce but were in a poor financial position (Baltussen et al. 2010).

Around two-thirds of the farms had 300 or more sows and/or 1500 or more fattening pigs. This indicates that some farms had sows as well as fattening pigs, but they did meet the selection criterion of at least 300 sows or at least 1500 fattening pigs. Table 1 gives an overview of the sample of farms used in this study. Farmers in the sample had an average age of 47, with a range between 27 to 67 years. In terms of age, the sample seems rather representative, as farmers who have confined farms (pigs, cattle, poultry) show a similar breakdown in age[4] (LEI and CBS 2011). The largest group of farmers in our sample had mid-level vocational training, which is also representative of farmers in the Netherlands (between 50 and 60%) (Van der Meulen et al. 2011). In general, the average turnover of breeding farms was 336 000 euros; and the average turnover of the fattening pig farms was 546 300 in 2010 (LEI and CBS 2011). Our sample includes medium-to large-size companies, which explains why around 48% of the farms had a turnover of 1 million euros or more. About 60% of the farmers in our sample had a designated successor.

Table 1 Sample Overview

Farmer							
Age	**Average Age**	**Range**					
	47	27 - 67					
Education	**N**		**N**		**N**		**N**
Secondary school	50	**Mid-level vocational training**	309	**Higher-level vocational training**	58	**Academic**	5
Farm /company							
#of sows	**N**	**# of fattening pigs**	**N**	**Turnover**	**N**		**N**
300 <	138	1500 <	135	1 million <	233	1 million = >	180
300 = >	269	1500 = >	267				
Age company	**N**		**N**	**Successor**	**N**		**N**
20 years <	63	20 years = >	379	No	266	Yes	163

Note. Not all the numbers collected from the 444 surveyed cases are included in this example. Some where missing values.

Measurements

The measurements of absorptive capacity developed by Jansen et al. (2005) were used as a starting point for the 7-point Likert scale questionnaire. The statements were adapted in such a way as to assure that the pig farmers would recognize their own situation within the statements and be able to complete the questionnaire within 15 minutes. For example, the questions about acquisition developed by Jansen et al. (2005) take into account the interactions and exchange of knowledge among the different divisions and units in large firms. However, as even the large pig farms in the Netherlands do not have different divisions of employees, only those items which reflect the farmer's own organizational capacity to interact with external actors are taken into account. In the case of acquisition, two of the items from Jansen et al. (2005) were adapted[5] and

[4] It is possible that the farmers who replied to our questionnaire were more inclined to do so because they are more open towards innovation. However, tests that compared the responses of the group of farmers who replied in the first two weeks after the questionnaire was sent (before we started to approach the remaining farmers by telephone to ask for their participation) and the farmers who replied after that did not show a significant difference in the level of innovativeness.

[5] Regarding Jansen et al., "We collect industry information through informal means, e.g. lunch with industry friends, talks with trade partners" (Jansen et al. 2005, 1014). Our item: 'We collect information about developments in the sector through discussions with business partners from the sector.'

two items were added which focus on the capacity (time and skills) of the farmer to engage in interactions with external actors. The questionnaire was tested by two academic experts on the pork sector in the Netherlands. In addition to questions about absorptive capacity, the questionnaire contained questions about the networking frequency of farmers and questions which provide general information about the farmer and the farm/company (see Table 2 for an overview of the operationalizations of the measurements and the Appendix for an overview of the questionnaire). In this section the variables used in the model will be described.

Networking Frequency

For the measurement of networking frequency a list of potentially relevant actors in the chain and the wider network for pig farmers was included in the questionnaire (see the Appendix for the exact list of actors included). The farmers were asked to indicate the frequency of contact with each of these actors. In addition to chain actors, the list included (financial) advisors, governmental institutions, branch organizations, knowledge institutes, certifying organizations and animal welfare and environmental organizations. As networks create access to new knowledge and facilitate the learning process (Cohen and Levinthal 1990), it is considered that frequency of contact with relevant actors in a potential network has an effect on absorptive capacity and level of innovativeness. New knowledge, for example about technology, is often proprietary, tacit, and difficult to value and transfer (Winter 1987). Frequent interactions allow for greater openness, and, hence, facilitate transfer of knowledge (Kale et al. 2000). The overall networking frequency is considered in the model by calculating the average frequency of contact with a wide range of actors. The higher the overall average score on networking frequency, the higher the level of interaction between the farmer and a wider range of actors. In order to study which specific actors are most important for farmers' innovativeness with respect to People, Planet, Profit and Pigs (the 4 Ps), the largest differences between innovative and less innovative farmers (based on differences in innovation investments) are also discussed.

Absorptive Capacity

Different measures of absorptive capacity can be found in the literature. Cohen and Levinthal (1989; 1990) used R&D intensity. Veugelers (1997) and Cassiman and Veugelers (2002) measured it based on the presence of a fully staffed R&D department. Others have regarded the human capital level, such as Mowery and Oxley (1995) and Keller (1996) who considered investment in scientific and technical training and the number of scientists and engineers as indicators. Zaheer and Bell (2005) separated the effect of firm-specific capabilities / absorptive capacity on innovativeness from the effect of a firm's structural network position on innovativeness by regressing innovativeness on network structure and using the residuals from this regression as the measure of absorptive capacity of the firm. In the present study, the focus is confined to the definition of absorptive capacity in terms of organizational capacities and routines (Jansen et al. 2005) as developed by Jansen et al. (2005). Acquisition capacity was measured using four items concerning contact with partners for the purpose of collection of information about developments in the sector, attending of meetings organized by the sector, allocation of time and skilfulness in establishing contact with the relevant parties in the network. Six items were used to measure assimilation capacity. The statements concerned the skills and capacity to be among the first to detect changes in the market, regulations and technical possibilities, as well as time spent and skilfulness in deliberating with advisors to detect changes in the market, and the way in which ad-

justments were made at farm level to react to these changes. Five items were used to determine transformation capacity. Farmers were asked to what extent they store information for later use, how skillful they are in assessing the usability of external information, how much time they spend and how skilful they are in translating acquired information into changes and adjustments in the business of their own farms. Three items were used to measure exploitation capacity. The farmers were asked about their capacity to translate external information into new and improved business applications, whether the use of the acquired information contributes to their profitability, how much time they spend and how skilful they are in converting acquired information into profitability.

Innovativeness

In the case of pig farming, pressure from society and policy makers to increase attention to sustainability issues led to innovations which balance People, Planet and Profit aspects. In order to emphasize the animal welfare aspect, the additional aspect of 'Pigs' was added to this list, resulting in the People, Planet, Profit and Pigs concept (Hoste 2010; 2011). This means that aside from paying attention to the health and wellbeing of workers and the general population, environmental impact and economic sustainability for all participants in the chain, the welfare of the pigs was given specific attention in innovation (Hoste 2010; 2011). Many of the 4P innovations are not necessarily new to the world, but when applied in combination they are new to pig farms. For example, when applied together on a farm, solar collectors, wind energy and biomass plants constitute indicators of a higher level of innovativeness on the 4P innovation scale. Accordingly, extent of adoption of 24 possible 4P innovations is considered to reflect the level of innovativeness of farmers in the present study. For an overview, see the questionnaire in the Appendix. The farmers were asked to indicate to what extent they invest in these 24 innovations on their farms. In the model, the average score on the 24 innovations is considered as the measure of innovativeness. All 24 innovations have the potential to eventually contribute to profit.

Profitability

Due to the farmers' sensitivity about revealing financial information, three 7-point Likert scale items were used to measure profitability. The farmers were asked to indicate how profitable they are compared to their competitors and whether their turnover and growth are higher or lower than their competitors'. These types of questions (with a choice of answer on a Likert scale) have been used often (Powell 1996) and have been demonstrated historically to be highly correlated to accounting measures of performance (Baker and Sinkula 1999; Balakrishnan 1996; Dess and Robinson 1984; Venkatraman and Ramanujam 1987), such as return on sales or return on assets (Powell 1996). They have also been regarded as a reliable means of assessing performance (Pearce, Freeman and Robinson 1987).

Method of Analysis

The computations of inter-factor correlations, all the path coefficients, the coefficient of determination (R^2) and goodness of fit measures were performed using structural equation modelling and Lisrel 8.72. Structural equation modelling was performed to estimate direct and indirect effects. This type of analysis has the advantage of correcting for unreliability of measures. Table 2 provides an overview of the mean scores per item and construct, as well as the validity, reliabil-

ity and internal consistency of the measurement model. The constructs display satisfactory levels of reliability, indicated by composite reliabilities ranging from 0.79 to 0.87 (Kline 2010). All multi-item constructs met the criterion of convergent validity, with loadings significantly related to the underlying factor in support of convergent validity (Kline 2010).

Table 2. The Measurement Model

	μ[6]	sd	λ	R^2	α & CR
Networking frequency					
Average frequency of contact with a list of actors	2.8	0.5	.90	.80	
Acquisition	4.5	1.3			α = .79
We collect information about developments in the sector through discussions with business partners from the sector.	5.0	1.3	.48	.23	CR = .82
Our farm participated last year at least twice in meetings organized by the sector.	5.1	1.8	.68	.46	
We allocate a lot of time to the establishment of contact with parties who can provide us with knowledge and information about innovations in the sector.	4.3	1.5	.83	.69	
We have sufficient skills to establish contact with parties who can provide us with knowledge and information about innovations in the sector.	4.0	1.6	.88	.77	
Assimilation	3.7	1.2			α = .87
Our farm is always among the first to recognize shifts in technical possibilities.	3.7	1.4	.87	.75	CR = .90
Our farm is always among the first to recognize regulatory changes.	3.8	1.4	.81	.65	
Our farm is always among the first to recognize changes in market competition.	3.8	1.4	.82	.67	
Our farm is very skilful in detecting new possibilities to serve new customers.	3.6	1.6	.83	.69	
Transformation	4.1	1.2			α = .86
We allocate a lot of time to discussion with advisors about new trends in the market.	4.4	1.6	.70	.50	CR = .86
New information about developments in the sector is being stored for future reference.	4.4	1.7	.54	.29	
We are very skillful in quickly recognizing the usefulness of new, external knowledge.	4.4	1.5	.73	.53	
We confer monthly with external advisors about how changes in the market can be used to improve business at our farm.	4.3	1.7	.61	.38	
We attribute a lot of time to translation of external information into adaptations to our business.	4.2	1.6	.78	.61	
We translate external information directly into new business applications.	3.3	1.4	.71	.50	
Exploitation	4.2	1.3			α = .87
The use of externally acquired information contributes often to our profitability.	4.1	1.5	.76	.58	CR = .87
We allocate a lot of time to applying of acquired information in order to realize profitability.	4.3	1.5	.88	.78	
We have sufficient skills to convert external information into profitability.	4.1	1.5	.85	.73	
Innovativeness	2.0	0.7	.95	.90	
The average extent of investment in 24 specified hardware applications in the stables.					
Profitability	4.4	1.0			α = .81
How do you estimate your profitability compared to your competitors'?	4.6	1.1	.85	.72	CR = .85
Compared to our most important competitors our turnover is higher.	4.4	1.1	.79	.62	
Compared to our most important competitors our growth percentage is higher.	4.2	1.3	.78	.60	

Note. μ= mean score (range 1-7); λ = Standardized Structural Coefficient; R^2= Reliability; α = Alpha Cronbach; C.R. = Compound Reliability

[6] The use of Likert scale for analyses with arithmetic computations is criticised because of the possible psychological "distances" between the Likert-scale points or the inequality in the distance between the points. However, many studies support the treatment of such scales as if they are equal to interval data (e.g. Aaker et al. 2004 p. 285; Burns and Bush 2000 p. 314 ; Dillon et al. 1993 p. 276; Hair et al. 2006 p. 365-366).

Results

The mean scores in Table 2 indicate that the absorptive capacity of the pig farmers turns out to be mainly represented by deliberation with advisors for the purpose of acquisition and understanding of external developments and changes, which makes them simultaneously strong in the identification of the relevant sources of information. So in general it is these aspects of acquisition and assimilation capacity which are the strongest in terms of absorptive capacity of pig farmers. The capacity to transform and exploit is generally a weaker side of the farmers' absorptive capacity. Overall, they have a moderate capacity to be among the first to recognize technical, regulatory and market competition changes and possibilities to serve new customers, and to translate external information into new business applications and convert these into profit.

Table 3 provides the inter-factor correlation matrix for the studied variables. All of the different absorptive capacity dimensions turned out to be rather highly correlated. This confirms that they accurately represent the different dimensions of absorptive capacity. Correlations with other variables are significant, but provide for discriminant validity.

Table 3

Variable	NF	ACQ	ASS	TRA	EX	INN
Networking frequency (NF)	x					
Acquisition (ACQ)	.50**	x				
Assimilation (ASS)	.41**	.57**	x			
Transformation (TRA)	.28**	.61**	.72**	x		
Exploitation (EX)	.22**	.49**	.58**	.79**	x	
Innovativeness (INN)	.30**	.29**	.38**	.34**	.27**	x
Profit (PRO)	.17**	.31**	.38**	.49**	.59**	.31**

Note. Correlations ∗∗ $p < 0.01$; N = 444

Figure 2 provides a visual overview of the structural model and the structural coefficients. The significance of the paths is shown in this diagram. The relative importance of the variables is reflected in the magnitude of the coefficients. The overall fit measures indicate that the model fits the data well ($\chi 2$ (191) = 399.85 ,p < .001; GFI = .92; AGFI = .90; RMSEA = .05; RMR = .091; NFI = .97; NNFI = .98; CFI = .99). All of the modification indices for the beta pathways between major variables were small, which suggests that adding more paths would not significantly improve the fit.

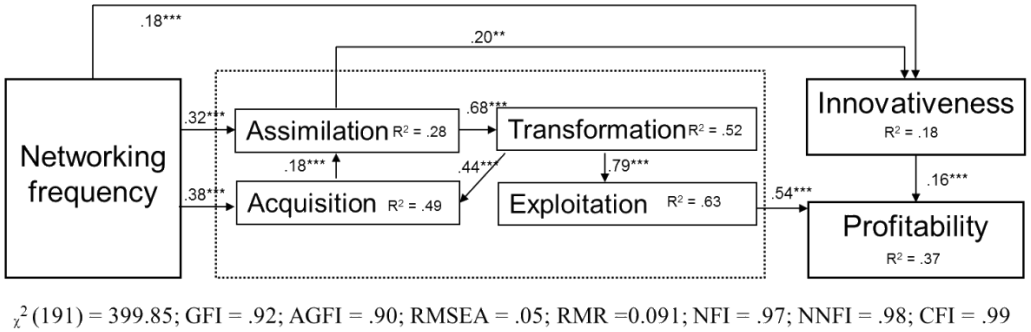

Figure 2. Structural Model
Note. ∗∗ p < 0.05; ∗∗∗ p < 0.01

Networking and Absorption

The findings from the parameter estimates show that, as expected, networking frequency is positively related to acquisition capability. Pig farmers with higher acquisition capacity have approximately bi-monthly to semi-annually contact with breeding companies, breeding farms, other pig farmers, slaughterhouses, consultancies, the branch organizations LTO[7] and NVV[8], Wageningen University (WUR) and Pigs Innovation Centre Sterksel[9]. An overview of these interactions is presented in Table 4. The pig farmers with lower acquisition capacity have less frequent contact with these organizations, namely about once a year. More frequent contact, through discussions and participation in sector-organized meetings with the mentioned actors, helps the farmers become more skilful in collecting relevant information and knowledge about developments and innovations in the sector.

Table 4. Comparison of networking frequency between innovators with high and low acquisition capacity

Acquisition	high	low		high	low		high	low
Breeding companies	■	●	Slaughterhouses	■	●	NVV	■-●	●-∞
Breeding farms	♠	■	Consultancies	♠	■	WUR	∞	⌂
Other pig farms	♠	♣	LTO	■	●	Sterksel	■	∞

Note. ♣ = monthly; ♠ = bi-monthly; ■ semi-annual; ● = annual; ∞ = less than annual; ⌂ = never or almost never

Frequent network contact is also positively related to assimilation capacity. As Table 5 shows, pig farmers with high assimilation capacity have the highest level of contact (approximately bi-monthly) with breeding farms and consultancies (for example related to feed, technical applications and installation, technical wholesale trade services or business advice).

Table 5. Comparison of networking frequency between innovators with high and low assimilation capacity

Assimilation	high	low		high	low		high	low
Breeding farms	♠	■	GD	■	●	ELI	●	∞
Slaughterhouses	■	●	Consultancy	♠	■	Sterksel	●	∞
Butcheries	●	∞	Product Boards Livestock and Meat (PVV)	●	∞	WUR	∞	⌂

Note. ♣ = monthly; ♠ = bi-monthly; ■ semi-annual; ● = annual; ∞ = less than annual; ⌂ = never or almost never

Slaughterhouses and health services for pigs (GD) are contacted approximately twice a year; and butcheries, Product Board Livestock and Meat (PVV), the Ministry of Economic Affairs, Agriculture and Innovation (ELI) and Sterksel are consulted approximately once a year. These farmers have contact with WUR less than once a year, whereas farmers with low assimilation capacity never or almost never have contact with the University. It is remarkable that farmers with the highest capacity to recognize shifts in technical possibilities, regulation and market competition

[7] LTO Nederland (Land- en Tuinbouw Organisatie) is the Dutch Federation of Agriculture and Horticulture, an entrepreneurial and employers' organisation, supporting their economic and social position.
[8] Dutch Pig Farmers' Union (NVV) is established to protect the interests of the pig farmers.
[9] Pigs Innovation Center Sterksel is a multi-functional research centre for modern, innovative and sustainable pig farming. The research covers all aspects of pig farming, including nutrition, welfare, health issues, housing and minerals management.

changes have only annual or less than annual contact with the research institutes. However, this frequency is still higher for farmers with high assimilation capacity than for those with low assimilation capacity.

In addition to the expected relations, it was found that networking frequency is positively related to innovativeness directly. Innovative farmers, who invest in 4P innovations, have more frequent contact with actors in the supply chain, banks, advisors and accountants as well as the health services agency for animals (Gezondheidsdienst voor Dieren - GD). This contact ranges bi-monthly to semi-annually in more innovative farms, while it is semi-annually to yearly in case of less innovative farms.

In addition to the higher networking frequency among farmers who invest more in 4P innovations, differences between different types of innovations were observed. As Table 6 shows, farmers who invest to a larger extent in pig welfare innovations have semi-annual contact with breeding farms and Sterksel, and less than annual contact with an additional number of actors, such as supermarkets, butchers, a government innovation institution (NL Agency[10]), knowledge and education institutions and animal welfare organizations. Farmers who invest in planet-profit innovations meet more or less semi-annually with Sterksel and butcheries, and slightly (less than annual instead of never) more frequently with breeding farms, supermarkets, the Ministry of Infrastructure and Environment (IM), NL Agency, Milieudefensie[11] and the Foundation for Nature and Environment (SNM). Pig farmers who invest more in people-profit-oriented innovations have about semi-annual contact with breeding farms, slaughterhouses and Sterksel and less than annual contact with butcheries, NL Agency, environment and animal welfare organizations such as Milieudefensie, SNM and foundation Wakker Dier, and knowledge and education institutions (such as Van Hall Larenstein).

Table 6. Comparison of the networking frequency between groups of innovators with high and low investment levels in Pigs, Planet, People and Pigs innovations

Investment in:	**Pigs**		**Planet**		**People**	
	high	low	high	low	high	low
Breeding farms	■	●	∞	⌂	■	●
Slaughterhouses					■	●
Sterksel	■	●	■	●	■	●
Butcheries	∞	⌂	■	●	∞	⌂
Supermarkets	∞	⌂	∞	⌂		
IM			∞	⌂		
NL Agency	∞	⌂	∞	⌂	∞	⌂
Knowledge and education inst.	∞	⌂			∞	⌂
Animal welfare organization	∞	⌂				
Wakker Dier					∞	⌂
Milieudefensie			∞	⌂	∞	⌂
SNM			∞	⌂	∞	⌂

Note. ■ semi-annual to annual ● = annual to less than annual; ∞ = less than annual; ⌂ = never or almost never

[10] NL Agency is the contact point for businesses, knowledge institutions and government bodies on issues related to sustainability, innovation, international business and cooperation. It provides information and advice on financing, networking and regulatory matters to entrepreneurs, (knowledge) institutions and government bodies.

[11] Milieudefensie is a movement of people who are committed and engaged, locally, nationally and internationally to contributing to the resolution of environmental problems (it is a foundation and member of Friends of the Earth International).

Absorptive Capacity

As expected, a positive relation was found between acquisition and assimilation. A higher capacity to establish contact with partners who can provide relevant information about changes and innovations in the sector (acquisition) impacts positively on the capacity to be among the first to recognize technical, regulatory and market-related developments and to evaluate how changes can be applied to one's own farm (assimilation). Pig farmers indicated that they acquire their information about developments in the sector mainly from discussions with business partners and participation in meetings organized by the sector (such as LTO).

Another expectation which was confirmed is that assimilation capacity has a significantly positive effect on transformation capacity. However, most farmers indicated that they have a low to moderate capacity/skilfulness to detect possibilities to serve new customers and only a smaller group indicated a moderate to high capacity to do this.

The capacity to transform knowledge into applications turns out to have a strongly positive effect on the capacity to acquire knowledge. This finding is logical since the transformation capacity of pig farmers is mostly reflected by their skill to quickly recognize the usefulness of new, external knowledge for applications on their own farms (e.g. by deliberation with advisors with regard to feed, technical applications and installation, technical wholesale trade services or business advice). Skilfulness in assessing the usability of new information, as well as regular deliberation with advisors about the way in which changes and trends in the market can be applied to one's own business, can lead to enhanced capacity to establish contact with the relevant sources of information. Table 7 indicates that farmers with higher transformation capacity have a higher frequency of contact with breeders and breeding companies, slaughterhouses and butcheries, but also with feed and feed system companies, other pig farmers, supermarkets, banks, consultancies and accountants, ELI, IM, NL Agency, NVV, PVV[12], WUR, knowledge institutes (Van Hall Larenstein), Sterksel, GD and SNM.

Table 7. Comparison of networking frequency between innovators with high and low transformation capacity

Transformation	high	low		high	low		high	low
Breeders	■	●	Supermarkets	∞	⌂	NVV	●	●-∞
Breeding farms	♣-■	♠-●	Banks	♣-●	■-●	PVV	●	∞
Feed companies	♣	♠	Consultancies	♣-●	■-●	WUR	∞	⌂
Feed system companies	■	●	Accountants	♣-●	■-●	Sterksel	●	∞
Other pig farms	♣	■	ELI	●	∞	Knowledge inst	∞	⌂
Slaughterhouses	■	●	MI	∞	⌂	GD	■	■-●
Butcheries	■	●	NL Agency	●	∞	SNM	∞	⌂

Note. ♣ = monthly; ♠ = bi-monthly; ■ semi-annual; ● = annual; ∞ = less than annual; ⌂ = never or almost never

As expected, transformation capacity also has a strongly positive effect on exploitation capacity. Skilfulness in assessing the usability and translation of new information for the purpose of application to changes in one's own farm contributes positively to the capacity to apply the acquired

[12] Productschap Vee en Vlees (product board for livestock and meat)

information to improvements and changes in one's own business in such a way as to realize profitability. The farmers indicated that especially the allocation of time to the application of acquired information reflects their exploitation capacity.

Absorption and Innovativeness

The general picture of investment in 4P innovations by pig farmers is as follows. Of the 444 farmers in the study, 41% have invested in fresh air farrowing pens, 31.2% in daylight, 36.6% in additional space per animal, 16.8% in conditioned air inlet and 15.4% in mist cooling. These are all pig-welfare-oriented innovations. In terms of planet-oriented innovation, 20.7% have invested in animal warmth recovery and 12.9% in solar panels. In terms of people-oriented innovation, 24.4% have invested in individual registration of feed and water intake and 16.1% in a Corn Cob Mix (CCM) feed facility.

While it was expected that transformation capacity would be positively related to innovativeness, we found that assimilation capacity is especially positively related to innovativeness. Transformation capacity is positively related to innovativeness, but only at the 0.10 significance level. This means that for pig farmers the capacity to recognize changes in technologies, regulations, market competition and consumer demands is most important to increase their level of innovativeness. Early recognition of these changes increases the likelihood that farmers will invest in 4P innovations. The farmers with higher assimilation capacity invested significantly more in fresh air farrowing pens, daylight, additional living space, conditioned air inlet, individual registration of feed and water intake and mist cooling. In addition, they invested slightly but significantly more in direct separation of urine and manure, solar collectors, micro-filtering of air, spraying robots, mixing space for sows and rubbing boards.

As already mentioned, networking frequency is also directly related to innovativeness. Table 8 shows that farmers with the highest networking frequency invested more in a larger number of innovations, while farmers with higher assimilation capacity invested specifically in pig welfare innovations. Farmers with high assimilation capacity invested in five pig- welfare- and one people-oriented innovation, while the farmers with high networking frequency invested in six pig-welfare-, two planet- and one people-oriented innovations. This indicates that assimilation capacity affects farmers' innovativeness by directing them more specifically towards animal welfare.

Table 8 Investments of farmers with high networking frequency ♣; and high assimilation capacity □

High networking frequency and high assimilation capacity					
Fresh air farrowing pens	♣	□	Mist cooling		□
Daylight	♣	□	Direct separation of urine and manure	♣	
Additional living space	♣	□	Solar collectors	♣	
Conditioned air inlet	♣	□	Animal warmth recovery	♣	
Individual registration of feed and water intake	♣	□	Rubbing boards	♣	

Profitability

The expectation that innovativeness is positively related to profitability is confirmed. However, this relationship is not very strong. One of the explanations for this may be that profitability in the case of 4P innovations does increase but that the return on investment takes more time, having a limited positive effect on short-term profitability. Of course, profitability is also a condition for financial room to invest in 4P innovations. However, the aim of the present paper is to establish whether higher innovativeness in the field of 4P innovations is positively related to profitability. The more general exploitation capacity of acquired information turns out to be much more strongly related to profitability than investment in these innovations. The capacity and skilfulness to exploit new information and knowledge in terms of their application to immediate business improvements contributes positively to the profitability of farms.

Table 9 Overview of the rejected and not rejected hypotheses

H1a: Networking frequency of pig farmers is positively related to their acquisition capacity.	Not Rejected
H1b: Networking frequency of pig farmers is positively related to their assimilation capacity.	Not Rejected
H2: Pig farmers' acquisition capacity is positively related to their assimilation capacity.	Not Rejected
H3: Pig farmers' assimilation capacity is positively related to farms' transformation capacity.	Not Rejected
H4a: Pig farmers' transformation capacity is positively related to exploitation capacity.	Not Rejected
H4b: Pig farmers' transformation capacity is positively related to innovativeness.	Rejected
H5a: Pig farmers' exploitation capacity is positively related to profitability.	Not Rejected
H5b: Pig farmers' innovativeness is positively related to profitability.	Not Rejected

Conclusions and Discussion

Networking and Innovativeness

Previous research established that weak ties and structural holes bridging organizational boundaries (Burt 1992; Rosenkopf and Nerkar 2001) provide access to diverse knowledge and information and are critical for innovation and innovativeness (Burt 2005). However, stronger ties, with frequency of contact as one of the indicators (Granovetter 1982; Krackhardt 1992), are considered important for the transfer of especially *complex knowledge* and information entailed in innovation (Hansen 1999; Reagans and McEvily 2003; Krackhardt 1992; Uzzi 1997). Reagans and McEvily (2003) advanced this discussion by establishing that network cohesion (overlapping ties among mutual third parties) and network range (relationships that span multiple knowledge pools) need not come at the expense of each other, but approach an optimal network structure which combines elements of both (Burt 2000; Reagans and Zuckerman 2001; Reagans, Zuckerman and McEvily 2003). The current research confirms the importance of stronger ties for the transfer of detailed knowledge by showing a positive relation between networking frequency and pig farmers' innovativeness. Furthermore, it can be concluded that diversity of knowledge is important but confined to a specific range of actors. In the case of investment in pig welfare, frequent contact with innovation centre Sterksel and breeding farms in particular, but also with supermarkets, butcheries, innovation, knowledge and education institutions, as well as animal welfare organizations is important.

In the case of planet-oriented innovations, it is important to maintain frequent contact with these same institutions, as well as the Ministry of Infrastructure and Environment and environment-oriented organizations such as Milieudefensie and SNM. The latter play a role in issues such as

reduction of manure surplus and ammonia emissions. The list of frequent contacts of farmers who invest in people-oriented innovations resembles that of farmers who invest in planet-oriented innovations. The somewhat wider networks of the farmers who are engaged in planet- and people-oriented innovations than of those who invest in pig welfare may be related to the somewhat higher interest of the planet and profit innovators in the efficiency aspect. While pig welfare also contributes to better and healthier pigs, innovations which are aimed at planet (environment) and people (labour) have somewhat more emphasis on efficiency and higher returns than the pig welfare innovations. Greater interest in efficiency in general may lead the planet and people innovators to explore a larger number of possibilities in a wider network.

The Role of Absorptive Capacity in the Relation between Networking and Innovativeness

The model in Figure 2 confirms the strong relationship between the use of the network (sources), learning and absorption (Goes and Park 1997; Powell, Koput and Smith-Doerr 1996) by a significantly positive relation between networking frequency and absorptive capacity. While confirming the importance of the combination of strong ties and network cohesion with weak ties and structural holes (Reagans and McEvily 2003), the present study addresses the shortcoming of previous research which used proxies to account for absorptive capacity. In contrast, we took the actual organizational capacities to absorb knowledge into account. Escribano et al. (2009) and Tsai (2009) identify the moderating role of absorptive capacity in the relationship between collaborative networks and product innovation performance. However, in these studies absorptive capacity is again measured by means of proxies, such as a firm's total expenditure on in-house R&D activities and training programmes for technological activities in the past three years divided by the total number of employees in a current year. Caloghirou et al. (2004) find that, besides R&D intensity and number of employees that have an academic degree in a scientific or engineering field, also organizational attributes in terms of openness towards knowledge sharing (searching patent databases, reading scientific or business journals and joining strategic alliances) constitute important aspects for the enhancing of a firm's innovation performance. The findings of the current study show that frequency of contact in a specific network range affects innovativeness positively, but also indirectly through acquisition and assimilation capacity. Incidental deliberation with advisors is not enough. Instead, a proactive and strategic approach towards absorption of knowledge and use of the network is needed to assure that sufficient interest and dynamism are created to incite change.

Acquisition, Assimilation and Innovativeness

As already indicated, assimilation capacity is the most important dimension of absorptive capacity for innovativeness of pig farmers. This indicates that the factor "knowing" or the understanding of actor *i* of the knowledge and skills of actor *j* (Borgatti and Cross 2003) is among the most important dimensions of absorption. Also acquisition contributes to innovativeness through its positive effect on assimilation capacity. The capacity to identify the most important knowledge sources, discuss with business partners and participate in sector meetings (acquisition capacity) contributes positively to the ability to recognize relevant changes and possibilities. The capacity to be among the first to recognize changes and developments in technical possibilities, regulations and the market, and skilfulness to recognize new possibilities to serve (new) customers are most effective in increasing the likelihood that a farmer will invest in People, Planet, Profit and

Pigs innovations. The capacity to understand and assimilate more technical, legislative and business-related knowledge among these farmers affects their innovativeness by directing them more specifically towards animal welfare innovations.

Farmers with higher assimilation capacity have a wider network of less than annual and more regular contacts, which helps them to recognize changes in technical possibilities, regulations, market competition and consumer demands. The most important sources of information about new developments in the sector turn out to be other pig farmers and slaughterhouses in the chain, and the wider network including consultancies, the branch organization LTO, and knowledge and research institutions (WUR and Sterksel). This selection of actors indicates that farmers with higher assimilation capacity are indeed highly interested in increasing their understanding of technical, regulatory, market and consumer changes.

Transformation and Acquisition Capacity

Previous studies (Zahra and George 2002) indicate that potential (acquisition and assimilation) absorptive capacity has a positive effect on the realized (transformation and exploitation) absorptive capacity, which has a direct positive link to firm performance (Volberda et al. 2010). However, little attention is devoted to the relation in the other direction. The current study shows that there is also a significantly positive effect of transformation on acquisition capacity. The capacity to transform and apply knowledge to one's own farm is positively related to a farmer's capacity to skilfully make contact with the network actors who can provide knowledge about innovations in the sector. Farmers with higher transformation capacity look specifically at how breeding can contribute to improvements on their farm and how innovations can be translated into increase in returns through negotiations about prices (with slaughterhouses). At the same time, the differences in frequency of contact with a large number of other chain parties and stakeholders indicate that farmers with higher transformation capacity are aware of the value of each actor for a particular innovation and of the effectiveness of frequent contact.

Transformation, Exploitation and Profitability

As previous studies pointed out that potential and realized absorptive capacity need to be balanced because potential absorptive capacity is more long-term oriented and realized absorptive capacity focuses on the more short-term-oriented goals (Zahra and George 2002), the current study also leads to the conclusion that the two dimensions of realized absorptive capacity, transformation and exploitation capacity, are the more important dimensions for profitability. The current research shows that investment in People, Planet, Profit and Pigs innovations is positively related to profitability. However, the general capacity to exploit external information and knowledge is more important for profitability than investment in these innovations. Allocation of time to apply the acquired information and sufficient skill to convert external information into profitability are highly important for realization of profit.

Practical Implications and Suggestions for Further Research

In their study Hult, Hurley and Knight (2004) confirm that not only learning, but also entrepreneurial and market orientation are antecedents of innovativeness. The findings of the current

study support this conclusion. Assimilation capacity and networking frequency explain 18% of variance in innovativeness, which means that other aspects also affect innovativeness. Entrepreneurial antecedents of pig farmers' innovativeness could be represented by their level of risk adversity. How much risk a farmer is willing to take, which type of innovation he is willing to engage in and how long he would like to continue his business could affect his level of innovativeness. These issues need further investigation.

Farmers' level of innovativeness is dependent not only on their ability and willingness to engage in innovation, but also on the type of innovation and the chain-wide organizational requirements (Wiskerke and Roep 2007; Broring 2008). In the present paper, innovativeness among farmers is defined as investment in (hardware) People, Planet, Profit and Pigs innovations. However, there are different types of innovations and especially those which go further than optimization require a very proactive attitude, continuous learning and a drive to change, as well as collaboration with and the support of other chain actors. Given the surplus of pig meat in Europe and strong competition in the entire supply chain, cooperation is needed to realize innovation on chain level. The question is what role the pig farmers need to play in each of the different types of innovations and which (chain) actor should be leading. A good example is the Beter Leven (better life) concept, developed by the animal protection society (Dierenbescherming), in cooperation with retailer Albert Heijn and meat company Vion. Animals are produced at a higher welfare standard and sold at a slightly higher price. This kind of marketing concept based on sustainability items has been developed further by other retailers and companies. The supermarkets play a major role in the establishment of the meat price and are important in organizational terms for the realization of innovation in this area. Interesting for future research is thus the mapping of the role of different chain actors with respect to different types of innovation and the specific knowledge (types) required to enable these different types of innovation. Specific knowledge and collaboration among specific actors for the purpose of solving the welfare problem is different from knowledge and collaboration with actors in development of new market concepts, since innovations take place at the farm, instead of just at the meat processing level.

In addition to the learning and entrepreneurial orientation, as well as the organizational requirements attached to the type of innovation a farmer engages in, the financial capacity and general economic situation need to be taken into account as determinants of innovativeness. The extent to which farmers are successful in acquiring financial means for innovation from their network is difficult to establish, but 48% of the farmers indicated that they make use of their network intensively for the purpose[13] of acquiring funding or subsidies. With respect to investments in (hardware) stable changes, a poor economic situation provides little room for investment. For this reason, farmers need the security of knowing that added value concepts will last long enough to pay back the additional investments.

The current model reflects the situation for pig farmers in north-western Europe, whereas farmers in southern and eastern Europe find themselves at a different level of development in terms of entrepreneurship, professionalization and efficiency. The relationships between networking behaviour, absorptive capacity and innovativeness are probably very different in these regions as

[13] Furthermore, 68% uses the network intensively for information about veterinary issues, 55% to gather information about rules and regulations, 38 % for (information about) animal welfare, 35% for collaboration purposes and 29 % for marketing ends.

they have other routines and perceptions about the sharing of information (e.g. study clubs where farmers learn from each other are common in the Netherlands but much less so in countries like Poland or Spain)[14]. Further research is needed to find out how networking, learning and innovativeness are related in these different contexts.

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[14] Moreover, production in these and many other countries often takes places in vertical integrations, where innovations are differently organized.

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Appendix 1

The Questionnaire

Function	**Age**	
Education *Circle one option*	Secondary school / Mid-level vocational training / School of applied sciences / University	
Number of pigs	**Number of sows**	
Number of employees	**Number of employees involved in innovation**	
Our company has existed for	❑ 0 to 5 years ❑ 5 to10 years ❑ 10 to 15 years	❑ 15 to 20 years ❑ 20 years or longer
In the event that you would retire in five years, is there a designated successor to take over your company?	❑ No ❑ Yes, my son / a buyer	
Turnover in the year 2010 (in euros) was	*Please choose one of the options*	
❑ Less than 300,000	❑ 1 - 2 mil.	
❑ 400,000 - 600,000	❑ 2 - 4 mil.	
❑ 600,000 – 800,000	❑ 4 - 8 mil.	
❑ 800,000 - 1 mil.	❑ 8 mil. or more	

Networking Frequency

How often do you have contact with each (category of) organization(s) for your access to external knowledge and information?

Please choose the option that best approaches the actual situation.
1= never 2= less than annually 3= annually 4=semi-annually 5= bi-monthly 6= monthly 7 = weekly

Company/organization	**Certifiers**	**Knowledge institutions**
Feed companies	PVV -CBD/VERIN[15] (IKB Pigs)	Wageningen University
Feed systems companies	De Green lobbyist (DGB) (IKB Netherlands Pigs)	Van Hall Larenstein
Veterinaries	SKAL (EKO)	HAS Den Bosch
Pig / sow farmers	Foundation Milieukeur	Pigs Innovation Centre Sterksel
Abattoirs / slaughterhouses	**Government institutions**	**Animal welfare and environment**
Meat processors	Ministry of Economic Affairs, Agriculture and Innovation	Animal protection
Transport companies	Agentschap.NL	Health services agency for animals (GD)
Supermarkets	**Branch organizations**	Milieudefensie
Butcheries	Agriculture organization Netherlands (LTO)	Foundation Wakker Dier
Banks	Dutch pig farmers' union (NVV)	Party for Animals
Consultancies	Product Board Livestock and Meat (PVV)	Society for Nature and Environment (SNM)
Accountants		

[15] Verification Institute Quality systems

Appendix 1. The Questionaire-*Continued*

Indicate to what extent you make use of external sources, knowledge and information for the following issues:

1 = very poorly and 7 = intensively

- *Animal welfare*
- *Veterinary issues*
- *Marketing*
- *Regulation*
- *Environmental issues*
- *Subsidies*
- *Collaboration*

Indicate to what extent you agree with the following statements: 1 = completely disagree and 7 = completely agree

Acquisition capacity
- *We collect information about developments in the sector through discussions with business partners in the sector.*
- *Our farm participates at least twice a year in seminars and sector-organized conferences to upgrade our expertise and knowledge.*
- *We allocate a lot of time to the establishment of contact with parties who can provide us with knowledge and information about innovations in the sector.*
- *We have sufficient skills to establish contact with parties who can provide us with knowledge and information about innovations in the sector.*

Assimilation capacity
- *Our farm is always among the first to recognize shifts in technical possibilities.*
- *Our farm is always among the first to recognize shifts in regulation.*
- *Our farm is always among the first to recognize shifts in market competition.*
- *Our farm is very skilful in detecting new possibilities to serve new customers.*
- *Our farm allocates a lot of time to deliberating with advisors in order to recognize changes in the market early.*
- *Our farm has sufficient skills to deliberate with advisors about how changes in the market can be used to make changes to the business on our farm.*

Transformation capacity
- *We record and store newly acquired knowledge for future reference.*
- *Our farm quickly recognizes the usefulness of new external knowledge to our existing knowledge.*
- *We discuss monthly with external advisors how trends in the market could be used to improve our business.*
- *We allocate a lot of time to translation of external information into adaptations to our business.*
- *We have sufficient skills to translate external information into adaptations to our business.*

Exploitation capacity
- *We translate external information directly into new business applications.*
- *Application of external information to our business contributes to our profitability.*
- *We have sufficient skills to convert external information into profitability.*

Profitability 1=much lower and 7=much higher
- *How do you estimate your profitability compared to your competitors'?*
- *Compared to our most important competitors our turnover is:*
- *Compared to our most important competitors our growth percentage is:*

Appendix 1. The Questionaire-*Continued*

Innovativeness

We are investing in: 1 = not at all; 4= in a part of the company; 7=in the entire company

o Balance farrowing pens	o Micro-filtering of air
o Fresh air farrowing pens	o Conditioned air inlet
o Watras farrowing pens	o Individual registration of feed and water intake
o Direct separation of urine and manure	o LED light
o Biomass plants	o CCM facility
o Wind energy	o Mechanical broadcast
o Solar collectors / solar panels	o Spraying robot
o (Animal) warmth recovery / exchanger	o Mixing room sows
o Daylight - more than 2% stable surface	o Mist cooling
o Additional space per animal	o Pad-cooling
o Exit to open air	o Shoulder cooling
o Rooting place	o Rubbing board

