Transition through markets

Understanding diffusion of added-value markets among Dutch pig farmers

Floor H.W. Ambrosius

Propositions

1. To change farmers, change markets.
   (this thesis)

2. Agent-based model results are useless, agent-based modelling is not.
   (this thesis)

3. One scientist's conceptual model is another scientist's prison.

4. Specialised researchers should devote a fixed amount of time to interdisciplinary research to support systemic problem solving.

5. Combining a PhD-thesis with other interesting work is necessary for perfectionists to maintain their sanity.

6. In analogy to 'COVID-19-leave' for working parents, we should introduce 'catch-up-on-sleep-leave' for working parents of young children.

Propositions belonging to the thesis, entitled

'Transition through markets: understanding diffusion of added-value markets among Dutch pig farmers'.

Floor H.W. Ambrosius

Wageningen, 16 June 2021

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This research was conducted under the auspices of Wageningen School of Social Sciences (WASS)

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Floor Hendrikje Willemien Ambrosius

Thesis

Submitted in fulfilment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus,
Prof. Dr A.P.J. Mol,
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Wednesday 16 June 2021
at 1:30 p.m. in the Aula.

Floor Hendrikje Willemien Ambrosius

Transition through markets – Understanding diffusion of added-value markets among Dutch pig farmers

202 pages

PhD thesis, Wageningen University, Wageningen, the Netherlands (2021)
With references, with summaries in English and Dutch

ISBN 978-94-6395-723-6
DOI https://doi.org/10.18174/542180

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CHAPTER 1

GENERAL INTRODUCTION

1.1 PROBLEMS IN THE DUTCH PORK SECTOR

Dutch pork producers experience societal pressure because Dutch consumer-citizens expect them to produce affordable meat while criticizing them for negative externalities. Their criticism focuses on, e.g., stench, impaired animal welfare, manure excess, public health risks, a higher risk for zoonoses, 'megafarms', and air pollution (Bergstra, 2013; Coenraadts & Cornelissen, 2011; Hendrickson & Miele, 2009; Maassen, Smit, Wouters, van Duijkeren, & et al., 2017; Natuur & Milieu, 2017; Stichting Varkens in Nood, 2015). 80-85% of pig farmers currently produce for the conventional international market (Jukema, Ramaekers, & Berkhout, 2020). These pig farmers experience pressure on farm continuity due to an increasingly competitive international market, subject to volatile feed and meat prices. The requirements to improve animal welfare and/or reduce environmental impact comes with additional investments increasing production's cost price (Greef & Casabianca, 2009). The increase in cost price results in further pressure on product margins for farmers. For example, more space per pig and reducing ammonia emissions via air scrubbers increase the investments per pig and the cost price. For pig farmers to survive, investment strategies are needed to compensate the higher production cost. So far, pig farmers have mainly responded through scale enlargement (Greef & Casabianca, 2009) to profit from economies of scale, such as lower feed prices due to larger volumes or improved labour efficiency. Since societal protests against 'megafarms,' this has become a controversial investment strategy.

Therefore, policy-makers and pork sector experts propose the conversion to added-value markets as a way out of this impasse (Backus & Schans, 2000; Den Ouden, Dijkhuizen, Huirne, & Zuurbier, 1996; Greef & Casabianca, 2009; Provincie Noord-Brabant, 2017). Added-value markets are markets that incorporate extra costs to reduce negative externalities of production in the final product's price. Farmers who produce for an added-value market, receive a price premium to compensate for these extra costs (Greef & Casabianca, 2009). In the Dutch pork sector, two types of added-value markets are distinguished. The first is the intermediate market segment. In this market segment, animal welfare, environmental performance, or both are slightly higher than set by law. The best known intermediate market segment is the '1-star better life' (1 ster beter leven) concept established by the Dutch Society for the Protection of Animals. The concept focuses on improving animal welfare. In this concept, fattening pigs have, among other

things, 1.0 m^2 of living space instead of 0.8 m^2, extra distraction material, and males are not castrated (Dierenbescherming, 2018). The switch from conventional to 'one-star better life' constitutes a reversible investment, as it requires replacement of inventory only (Gocsik, Oude Lansink, Voermans, & Saatkamp, 2015). The second is a niche market-segment. The best-known niche segment is the organic market, which has the maximum score of three stars from the Dutch Society for the Protection of Animals. In this concept, fattening pigs have, among other things, outdoor access, a total living space of 2.3 m^2 per pig (indoor plus outdoor), and straw bedding instead of a concrete floor (Dierenbescherming, 2018). It is an irreversible investment, i.e., it requires investment in the building, not just in inventory (Gocsik, Oude Lansink, Voermans, & Saatkamp, 2015).

In the past, policy makers have tried to influence added-value market adoption with subsidies. A subsidy to stimulate conversion to organic pork production resulted in an over-supply of Dutch organic pork and a decreased image of organic pig farming as a viable alternative among farmers (Biologica, 2003). Also, farmers are reluctant to convert to another market because they feel peer pressure to remain conventional or defend their choice for alternative farming strategies like organic (Alexopoulos, Koutsouris, & Tzouramani, 2010; Lamine & Bellon, 2009). These examples illustrate the obstacles for change and reveal the friction between societal desires and farmer and market dynamics. To understand the diffusion of added-value markets among the pig farmer population, a better understanding of the factors that influence farmer decision-making behaviour regarding alternative farming strategies is needed, including farmer-to-farmer interactions and farmer-market price dynamics. This is what this thesis is about – understanding the diffusion of added-value markets among pig farmers by looking at pig farmers in interaction with each other and their environment. Below I first outline current research on farmer behaviour and insights from social-psychological theory. Then I get to the research questions addressed in this thesis.

1.2 FARMER DECISION-MAKING BEHAVIOUR: EMPIRICAL EVIDENCE

So far, research on farmers decision-making behaviour regarding alternative farming strategies has focused on farmers' individual considerations, farm(er) characteristics, and the policy context.

Individual considerations and farm(er) characteristics associated with the adoption of alternative farming practices are, for example, farmers' innovativeness (Aubert, Schroeder, & Grimaudo, 2012; Tepic, Trienekens, Hoste, & Omta, 2012); an open attitude in general (Austin, Deary, & Willock, 2001) or a positive attitude towards the alternative farming practice (Hyland, Heanue, McKillop, & Micha, 2018); extrinsic financial motivations (Mills, Gaskell, Ingram, & Chaplin, 2018); risk perceptions (van Duinen, Filatova, Geurts, & van der Veen, 2015); younger age and having a successor (Kemp, Nijhoff-Savvaki, Ruitenburg, Trienekens, & Omta, 2014; Tuyttens, Struelens, Van Gansbeke, & Ampe, 2008); profit orientation (Kemp et al., 2014); and certainty about price premiums (Gocsik, van der Lans, Lansink, & Saatkamp, 2015). Research has explained farmers' heterogeneity by investigating individual considerations (Burton & Wilson, 2006; Commandeur, 2006; van der Ploeg, 1994; Vanclay, Howden, Mesiti, & Glyde, 2006). This type of research showed that farmers differ in self-concept and related 'good farming practices' (Burton & Wilson, 2006), also referred to as farming styles (Commandeur, 2006; de Rooij, de Lauwere, & van der Ploeg, 2010; van der Ploeg, 1994). Based on these studies, we can group pig farmers in three relatively stable farming styles over time: idealists who focus on life-style concerns and pigs' intrinsic needs; craftsmen who concentrate on production results and stewardship, and entrepreneurs who concentrate on competition and profit.

All of these studies were done at one point in time and did not consider a change in time or the effect of interactions between farmers. In contrast, several studies indicate that social influence plays a role in farmer decision-making behaviour. For example, the professional network (including other farmers' opinions) was the second-largest contributor to farmer decision-making in a Swiss and American case study region (Celio, Flint, Schoch, & Grêt-Regamey, 2014). Tepic et al. (2012) found that farmers with innovative farm designs had a higher networking frequency than farmers with traditional farm designs. Alexopoulos et al. (2010) showed that farmers who wanted to reconvert from organic to conventional farming practices, had less support from important others

to farm organically and knew less other organic farmers than those who did not wish to reconvert. Besides, research points out that farmers are influenced by what they perceive to be the dominant norms for behaviour within the farmer community. In the Netherlands, those farmers who did not yet convert to a group housing system for sows, felt less peer pressure from, e.g., other farmers (de Lauwere, van Asseldonk, van 't Riet, de Hoop, & ten Pierick, 2012). Finally, the existence of only few, dominant farming styles within the pig farmer population indicates conformity (Vanclay & Silvasti, 2009). When understanding the effect of farmer decision-making behaviour on the diffusion of added-value markets, we need a framework that incorporates all essential factors that influence pig farmers' decision-making including the influence resulting from farmer-to-farmer interaction.

1.3 INSIGHTS FROM SOCIAL PSYCHOLOGY

A framework for farmer decision-making behaviour should, thus, integrate different antecedents of behaviour and allow for the feed-back effects of farmer decision-making behaviour on the factors that influence it. Social-psychology literature combines cognitive factors of behaviour with the social part of the self-concept. Below we will elaborate on two social-psychological theories that will be used in this thesis: the reasoned action approach and the social identity approach. The reasoned action approach, developed by Fishbein and Ajzen (Ajzen, 2012; Fishbein & Ajzen, 2010), is one of the most used and integrated models for understanding farmer decision-making behaviour (Rose, Keating, & Morris, 2018). The social identity approach, following Brown (2000a) and Hornsey (2008), provides a framework for conceptualizing the effect of social interaction on behaviour.

1.3.1 THE REASONED ACTION APPROACH

The reasoned action approach is a framework for deliberate decision-making regarding a specific behaviour. The individual's characteristics are important and his/her social and contextual perception of the current situation. It is used to predict and explain individual behaviour and argues that intention is the immediate antecedent of behaviour (Ajzen, 1991; Ajzen & Fishbein, 2005; Fishbein & Ajzen, 2010). Intention, in turn, is influenced

by three primary constructs: attitude, subjective norm, and perceived behavioural control (Ajzen & Fishbein, 2005; Fishbein & Ajzen, 2010). The attitude represents beliefs about the positive or negative consequences of the behaviour in question. The subjective norm consists of two types of norms: injunctive and descriptive norms. Injunctive norms represent an individual's beliefs on whether important others would approve of the behaviour. Descriptive norms represent the individual's perception of whether important others perform the behaviour (Fishbein & Ajzen, 2010). The perceived behavioural control represents beliefs "about resources and obstacles that can facilitate or interfere with" the individual's attempt to carry out the behaviour (Ajzen, 2012: 18). This can be partly influenced by the actual behavioural control, which determines whether or not the individual is able to perform the behaviour (Fishbein & Ajzen, 2010). If the individual has actual behavioural control over the behaviour, intention becomes a stronger predictor of behaviour (Ajzen & Fishbein, 2005).

Although the framework incorporates different factors that influence farmer decision-making, the constructs that influence behaviour can be variable over time (Feola & Binder, 2010). For example, attitudes are subject to change due to social interaction, situational factors, experience, or a combination of these factors (Helitzer, Hathorn, Benally, & Ortega, 2014; Petty & Wegener, 1998; Wood, 2000). In a farmer context, this is, for example, shown in the research by Helitzer et al. (2014). They found that after training six "model farmers" who trained 120 farm families, pesticide storage behaviour improved, and attitudes about the compatibility and relative advantage of pesticides changed.

Therefore, the reasoned action approach needs further refinement to allow for social interaction dynamics on the constructs that influence behaviour. More specifically, social influence through interaction should be linked to reference groups, i.e., a real or perceived group whose opinion and behaviour matters to one's choices (Brown, 2000; Kemper, 2011). Three observations in the literature support this. First, farmers are reluctant to changes that drive them away from their definition of 'good farming practices', i.e., their dominant self-concept (Burton & Wilson, 2006). Second, researchers categorise farmers into different farming styles instead of each farmer having its own (Vanclay & Silvasti, 2009). Third, organic farmers in the past were mostly associated with idealistic motivations of 'good farming practices' opposing conventional farming methods, while conventional farmers disparaged idealists and organic farming practices (de Rooij et al., 2010). These three observations suggest that different mechanisms are at work that drive

group formation and behaviour. Farmers behave according to the reference group of their social identities; the most important of these are the peers of their farming style.

The social identity approach, comprised of social identity theory and self-categorisation theory, links the social part of the farmers' self-concept to social influence as a consequence of interaction (Hornsey, 2008). In other words, it provides a framework for understanding how and why social interactions can lead to behaviour change and affect the diffusion of added-value markets.

1.3.2 THE SOCIAL IDENTITY APPROACH

In essence, social identity theory assumes that an individual's identity, or self-concept, is built up of several group identities, also termed reference groups. Something is a reference group when two or more members identify themselves as members of the group and at least one other person recognizes it as a group (Brown, 2000a: p3). Self-categorisation theory explains the cognitive mechanisms of social identities on behaviour (Hornsey, 2008). The main idea behind self-categorisation theory is that humans have a universal drive to evaluate their opinions and attitudes to increase their self-esteem, confidence, and status as a group member (Brown, 2000; Hogg, Terry, & White, 1995; Turner & Oakes, 1986). Individuals within a group are motivated to act according to the norms associated with being a member (Brown, 2000), and disagreement in opinion or attitude between in-group members can result in an attempt to reduce the disagreement through social influence (Bagozzi & Lee, 2002; Brown, 2000; Turner & Oakes, 1986). The level of social influence, in turn, is based on (1) similarity between self and other(s), i.e., whether they are in-group or out-group members; (2) the similarity of the situational context between self and other(s); (3) the status of oneself and the other(s) within the group, i.e., the direction of influence, and (4) the level of identification with the in-group (Brown, 2000; Terry & Hogg, 1996; Turner & Oakes, 1986). To understand influence through farmer-to-farmer interaction, it is, therefore, essential to know about groups in the farmer population, what gives status within a particular reference group, relevant similarity factors between farmers for the decision at stake, and relevant similarities in situational context between farmers for the decision at stake. Thus, the social identity approach provides an interesting framework to understand the mechanisms of social influence that affect behavioural change.

In this thesis, we regard the farmers' dominant self-concept (Burton & Wilson, 2006) as equal to the farmers' farming style (Commandeur, 2006; de Rooij et al., 2010), and the farmers' farming style as equal to the farmers' salient reference group that influences the farmer's behaviour. Also, all farmers who can influence the farmer's behaviour, e.g., farmers who are similar in context or farmers who are higher in status, are regarded as reference groups.

1.4 THE DUTCH PORK SECTOR AS A COMPLEX ADAPTIVE SYSTEM

As can be seen above, research has shown that farmers are heterogeneous in their traits, they are influenced by many factors, they adapt to changes in their environment, and social interactions between farmers can influence adoption decisions. Together this can affect macro-level outcomes such as the diffusion of added-value markets. Systems that are comprised of heterogeneous individuals, who adapt to changes in their environment, interact and influence each other, and can affect macro-level system outcomes, can be called Complex Adaptive Systems. Complex adaptive systems are systems that are comprised of multiple components, often called agents, that interact. Interactions between system components can result in non-linear emergent macro-level patterns (Holland, 2006), such as the diffusion of innovations. Therefore, a Complex Adaptive Systems approach has the potential to connect micro-level individual agent behaviour to macro-level structures. Something which individual snapshot studies of farmer decision-making behaviour are not able to do.

The Dutch pork sector can be seen as a *system* because it consists of different components that interact with each other, e.g., farmers, advisors, market prices, and government (for policy). It is *adaptive* because farmers respond to changes in their environment, and they do so heterogeneously. For example, one farmer might invest in scale enlargement in reaction to falling market prices for conventional meat. In contrast, another farmer might invest in organic market conversion to avoid volatile international meat prices. Another example is that one farmer might adapt his/her attitude towards a one-star intermediate market after interaction with another farmer, while a second farmer does not. The pork sector system is *complex* because the effect of interaction between

different system components can be non-linear and, therefore, hard to predict. A system's complexity lies in this interaction: e.g., one farmer's behaviour influences the context of another farmer. To make this more concrete: A conventional farmer who converts to organic production increases organic supply and thereby affects organic market prices, which changes the attractiveness of organic farming for other farmers. Or a well-known, respected conventional farmer who is cynical about the organic market can influence other farmers' perception of the organic market. There is, thus, a constant interaction between system structure(s) (e.g., norms in social groups, market prices, current farm resources) and individual agents (the decision space of individual farmers). When many farmers interact, the effect on farmers' attitude regarding alternative farming strategies is unknown beforehand. In other words, no-one steers the system, although some might try to influence it. Also, individuals are usually not knowledgeable about the effect of their individual behaviour on system outcomes. At the same time, interactions between system components do produce a pattern that matches the system and the environment.

Thus, a Complex Adaptive Systems approach requires a broadening of the research focus when trying to understand the spread of added-value markets. The scope of research should move from farmers' individual considerations to agricultural systems, i.e., encompassing relevant components and their interactions with each other. In the case of the Dutch pork sector this can include farmers, advisors, market price dynamics, and policies, and their interactions with each other. In addition, it is necessary to study the effect of interactions between system components on macro-level outcomes, e.g., diffusion of added-value markets. This adds a time component to understanding the diffusion of added-value markets.

1.5 OBJECTIVES AND RESEARCH QUESTION

To gain more insight in the diffusion of added-value markets it is important to understand diffusion as an outcome of interactions between system actors (e.g., farmers) and system components (e.g., farm resources and market prices). Due to the complex nature of these interactions, the link between farmers' adaptation behaviour, including farmer-to-farmer interaction, and the diffusion of added-value markets is poorly understood. This thesis aims to increase our understanding of the diffusion of added-value markets by taking a

complex adaptive system approach. We will answer the following sub-questions in this thesis in the context of the Dutch pork sector to reach this goal:

1. Which factors influence pig farmers' decision-making across time?
2. To what extent does social interaction affect the diffusion of investment strategies?
3. How do context and interaction influence the diffusion of organic farming?

Apart from these three main research questions, this study seeks to explore whether a Complex Adaptive Systems approach gives additional insights in understanding the diffusion of added-value markets and if the social psychological theories described above are helpful from a Complex Adaptive Systems perspective. In the General Discussion of this thesis, I will reflect on this.

1.6 OUTLINE AND METHODOLOGY

We studied the above questions with a combination of research methods. In Chapter 2, we answered the first research question with literature research on farmer decision-making behaviour and behavioural theory next to semi-structured in-depth interviews with pig farmers and experts. An integrated framework of pig farmer decision-making is developed that allows for feedback mechanisms of the effects of behaviour on the factors that influence behaviour.

In Chapter 3, we used simulation games to study the second research question. Simulation games provide an experimental setting that can grasp a real-world system's complexity while offering a higher degree of control over several variables (Anderies et al., 2011). Participants in the game can individually or collectively react to changes in their environment (Hofstede, de Caluwé, & Peters, 2010), e.g., another game participant's behaviour or market price changes. We designed the game in such a way that it stimulates communication between participants and we used it to observe behavioural responses as a consequence of social interaction within a specific context, as is done by Speelman et al. (2014). We analysed the extent to which social interaction between participants in the game play a role in the diffusion of investment strategies.

In Chapter 4, we studied the final research question through agent-based modelling and expert validation of the model results. Agent-based modelling is a computer simulation method. It is unique in its ability to model heterogeneous agents and micro-level interaction between these agents to generate and explore macro-level or group-level outcomes (Flache et al., 2017; Gilbert, 2008; Squazzoni, Jager, & Edmonds, 2014). Examples of macro-level and group outcomes that have been studied with agent-based models are innovation diffusion patterns (Berger, 2001; Deffuant et al., 2002; Kaufmann, Stagl, & Franks, 2009), segregation (Schelling, 1971), and opinion dynamics (Gargiulo & Gandica, 2017; Hegselmann & Krause, 2002). Therefore, the method can bridge the gap between local agents' socio-psychological heterogeneity and macro-level societal structures. In chapter 4 the technique was used to operationalise farmer decision-making behaviour, including social interaction mechanisms and price dynamics, to study its influence on the diffusion of organic farming in the Dutch pig sector.

In Chapter 5, the results are discussed in a broader context, with an emphasis on the added-value of a Complex Adaptive Systems Approach, the methodologies used, and the implications for policy-makers and other agricultural sectors. In addition, suggestions for further research are given, followed by a brief overview on the most important conclusions.

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CHAPTER 2

MODELLING FARMER DECISION-MAKING: THE CASE OF THE DUTCH PORK SECTOR

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British Food Journal 117 (10), pp. 2582-2597

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ABSTRACT

The purpose of this paper is to develop a framework that models farmers' strategic decision making, taking into account that farmers adapt to institutional changes, given the social structure in which they are embedded. First, a theoretical framework was developed using the reasoned action approach, innovation diffusion research, identity research, and the theory of structuration. Second, the framework was refined based on insights gained through semi-structured interviews with seven pork farmers and six pork farming experts on innovation decisions in general and added-value market adoption in particular. The farmer decision-making framework distinguishes personal characteristics, social influence related to reference groups, and the institutional context that determines the space for manoeuvre. The interviews reveal the importance of context specific factors, such as trust in policy and market requirements, and point at general mechanisms of path dependency as a result of previous decision making and social influence related to identity reference groups. The authors include feedback mechanisms between on the one hand social structure and institutional context, and on the other, farmer decision making. The framework is designed to explore the combined influence of factors of decision making on sector behaviour and study the relation between individual and collective behaviour.

Keywords: Identity, social influence, framework, innovation diffusion, agricultural systems, farmer decision making

2.1 INTRODUCTION

Farmer strategic decision-making in reaction to institutional changes may have unexpected influences beyond the farm boundary (Edwards-Jones, 2006). Unexpected influences arise from an interplay between farmers' interaction and their heterogeneous reaction to institutional changes (Geels & Schot, 2007). This can influence the spread of adaptation strategies over time, such as farm intensification, farm enlargement, or use of technologies. These strategies, in turn, affect landscape quality, public health risks, and environmental pollution. For policy makers and the public good, it is therefore of interest to gain insight in the dynamic processes that influence farmers. To better understand these adaptive dynamics, this paper attempts a time-dependent conceptual model of farmer strategic decision-making. For this, the conceptual model should include 1) feedback mechanisms and dynamics, and 2) captures the richness of factors by which farmers are influenced (Feola, Schoell, & Binder, 2010).

Previous research explains farmers' heterogeneous decision-making by their difference in resources, individual characteristics, reference groups and their problem definition (Dessein & Nevens, 2007; Edwards-Jones, 2006; Geels & Schot, 2007; van der Ploeg, 1993). Beedell and Rehman (2000), for example, showed that British farmers who are members of an environmental group experience more social pressure towards landscape conservation and consequently perform more conservation-related behaviour. Feola et al. (2010) revealed that farmers tend to conform to the behaviour that is most frequent among other farmers regarding the use of pesticide and personal protective equipment. Bock et al. (2010) found that many Dutch pork farmers changed their perception of animal welfare in reaction to citizens' concerns, and some pork farmers recognised the need to adapt their behaviour in response (de Rooij, de Lauwere, & van der Ploeg, 2010). Furthermore, research into the heterogeneity of behaviour has categorised farmers into a set of ideal types (Burton & Wilson, 2006; Commandeur, 2006; van der Ploeg, 1993). The existence of ideal types from which farmers choose, instead of each farmer creating its own strategy, is a process of conformity, showing that farmers are influenced by their social environment (Vanclay & Silvasti, 2009).

Most empirical research, that used an integrated framework of farmer decision-making to study the behavioural determinants of adoption decisions concentrated on individual considerations, through e.g. the measurement of attitudes and/or intentions (de Lauwere,

van Asseldonk, van 't Riet, de Hoop, & ten Pierick, 2012; Migliore, Caracciolo, Lombardi, Schifani, & Cembalo, 2014; Willock et al., 1999) with little space for dynamics at the collective level (Burton, 2004; Edwards-Jones, 2006). Some studies did account for social influence within an integrated framework of farmer decision-making: empirical studies based on the Theory of Planned Behaviour, for example, measured social influence as the summarized normative pressure from general important others (Beedell & Rehman, 2000; Burton, 2004; de Lauwere et al., 2012). The framework developed by Feola and Binder (2010) conceptualised and measured social influence by linking normative pressure from important others to the farmer's identity. Some simulation studies explored the effect of social influence within an integrated framework of farmer decision-making on adoption diffusion patterns over time (Deffuant et al., 2002; Gotts, Polhill, & Law, 2003; Kaufmann, Stagl, & Franks, 2009; Schreinemachers, Berger, Sirijinda, & Praneetvatakul, 2009; Weisbuch & Boudjema, 1999). In the simulation study by Deffuant et al. (2002) farmers updated their social norm in favour of the norm of the farmer whom they interacted with. Kaufmann et al. (2009) studied social influence from an opinion perspective; farmers differed in opinion on one dimension, i.e., for or against organic farming. None of these models, however, linked social influence to specific reference groups within the farming community, i.e., a group of farmers with similar ideas on what defines a good farmer, and none of them specified and quantified social influence accordingly.

This research aims to fill the gap by presenting an integrated framework of farmer strategic decision-making suitable for a time-dependent modelling context by allowing for 1) interaction between farmers and their institutional environment, 2) feedback mechanisms from farmers' previous decision-making and 3) social influence mechanisms linked to specific reference groups.

To test and improve the validity of the framework and check for general and case-specific factors, we applied the framework to the Dutch pork sector. Dutch pork farmers have experienced many institutional changes (Greef & Casabianca, 2009), to which they responded heterogeneously (Commandeur, 2006; de Rooij et al., 2010), while being influenced by each other (de Lauwere et al., 2012). The case, therefore, seems appropriate for this purpose. The paper is structured as follows. First, the case study and the methods applied are presented. Second, the conceptual framework is outlined. Next, the results from interviews with pork farmers are discussed, and the framework is improved accordingly.

2.2 MATERIALS AND METHODS

2.2.1 THE DUTCH PORK SECTOR

The Dutch pork sector is subject to social and political concerns around animal welfare, environmental impact, landscape quality and public health. These concerns are most prominent in the areas with the highest concentration of pork farmers, i.e. Noord Limburg and Noord-Brabant, where recent policy initiatives try to tackle these concerns (Coenraadts & Cornelissen, 2011). Many of these policies, however, cause an increase in cost price and threaten farms' economic viability. Some farmers try to overcome this by producing for an added value market, i.e. markets with certification schemes that have higher standards for production than minimally required by law (Backus & Dijkhuizen, 2002; Greef & Casabianca, 2009; Kinsey, 1999). These farmers produce for an intermediate or niche market. Intermediate markets stipulate certification requirements with small changes in housing systems compared to conventional systems and therefore require smaller investments, while niche markets go far beyond the minimal requirements set by law and demand large investments. Most Dutch pork farmers, however, still stick to their current cost price reduction strategies (Greef & Casabianca, 2009).

2.2.2 FRAMEWORK

First the framework of the model was constructed by combing concepts from sociology, social-psychology and innovation literature. We used the Reasoned Action Approach (RAA) as a basis for decision-making and adapted it to a time dependent modelling context that includes feedback mechanisms between farmers' previous behaviour, societal structure, and current farmer behaviour. Next, seven pork farmers and six experts were interviewed to test and improve the factors included in the theoretical framework. The main goal was to identify factors that contribute to investment decisions in general and identify factors that influence farmer decision-making regarding the adoption of added-value markets. We looked at two existing alternatives: the organic market, which is a niche market, and the 1-star intermediate market.

When selecting farmers for discussing the initial framework we aimed at approaching different types of farmers: farmers who produce for the organic and intermediate market, have other sources of income, and have small- to large-scale farms. The farmers were selected with the help of a farmer consultant of the Southern Agri- and Horticultural

Organisation of the Netherlands. All were located in the province of Noord-Brabant, the Netherlands, and held sows as well as fattening pigs. One farmer produced for the intermediate market and one for the organic market. Two had sources of off-farm income. Farm sizes differed from 28 sows and 200 fattening pigs, to 3200 sows and 6000 fattening pigs (see table 2.1).

TABLE 2.1. Basic characteristics of the interviewed pork farmers

Farmer	Off-farm income	Sows	Fattening pigs	Market
Farmer 1	5%	350	2200	Conventional
Farmer 2	-	3200	6000	Conventional
Farmer 3	-	260	4000	Conventional
Farmer 4	-	70	450	Organic
Farmer 5	70%	28	200	Intermediate – 1-star
Farmer 6	-	735	5000	Intermediate – privately owned
Farmer 7	-	710 & 400 gilts	400	Conventional

During the interviews we discussed the development of their farm: when did they innovate, why did they choose the innovation, and how did the process develop. In addition, we asked about their view on factors influencing the adoption of added-value markets: the advantages and disadvantages of added-value markets, which individuals or groups of people support added-value market conversion, and what factors make it easy or difficult to convert.

The interviewed experts were two animal scientists of whom one specialised in organic farming system, a pork farmer consultant specialised in permit procedures, a slaughterhouse advisor, an agricultural innovation sociologist, and an advisor from the Southern Agri- and Horticultural Organisation. The semi-structured interviews with experts contained questions related to their work-experience with farmers, and differences between the organic market and the recently developed intermediate market.

2.3 THEORETICAL FRAMEWORK

Four theories were used to conceptualise farmer decision-making: the Reasoned Action Approach (RAA) (Martin Fishbein & Ajzen, 2010), Innovation Diffusion Research (Rogers, 2003), Identity Research (Hogg, Terry, & White, 1995; Stets & Burke, 2000), and the Theory of Structuration (Giddens, 1984). RAA was chosen since farmers' strategic decision-making has medium to long term consequences for the farmer and is therefore likely to be preceded by a careful decision-making process (Kaufmann et al., 2009). Application of the RAA within an agent-based model design, however, has several challenges, which are further outlined below. These are addressed by combining the RAA with innovation diffusion research, identity research and the theory of structuration.

2.3.1 THE REASONED ACTION APPROACH

The Reasoned Action Approach (RAA, Figure 2.1.) (Martin Fishbein & Ajzen, 2010), an improved version of the Theory of Planned Behaviour (TPB) (Ajzen, 1991) and the Theory of Reasoned Action (TRA) (M. Fishbein, 1979), is a framework for deliberate decision-making, in which the individual's characteristics are important as well as his/her perception of the current situation. The RAA and TPB differ from the TRA by including the third factor, Perceived Behavioural Control, which has shown to be important in farmer decision-making (de Lauwere et al., 2012). The RAA differs from the TPB by specifying social influence processes. The RAA is used to predict and explain individual behaviour and argues that intention is the immediate antecedent of behaviour (Ajzen, 1991; Ajzen & Fishbein, 2005; Martin Fishbein & Ajzen, 2010). Intention, in turn, is influenced by three main constructs: attitude, subjective norm and perceived behavioural control (PBC) (Ajzen & Fishbein, 2005; Martin Fishbein & Ajzen, 2010). The attitude represents beliefs about the positive or negative consequences of the behaviour in question. The subjective norm consists of two types of norms: injunctive and descriptive norms. Injunctive norms represent an individual's normative beliefs on whether others would approve the behaviour. Descriptive norms represent the individual's perception on whether important others are actually performing the behaviour (Martin Fishbein & Ajzen, 2010). PBC represents beliefs 'about personal and environmental factors that can help or impede' the individual's attempt to carry out the behaviour (Martin Fishbein & Ajzen, 2010). This can be partly influenced by actual behavioural control (ABC),

which determines whether or not the individual is able to perform the behaviour. If the individual has actual behavioural control over the behaviour, intention becomes a stronger predictor of behaviour (Ajzen & Fishbein, 2005).

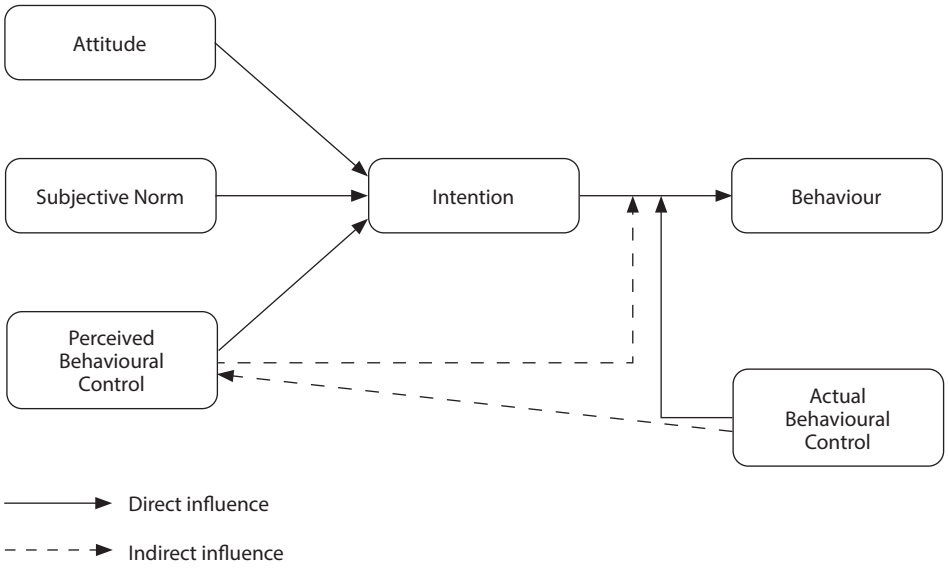

FIGURE 2.1. The Reasoned Action Approach (Martin Fishbein & Ajzen, 2010)

We want to apply the RAA to a time-dependent modelling context, where consequences of farmers' previous behaviour feedback to current farmer decision-making. Although RAA recognises that previous behaviour can influence individuals' behaviour, through expected outcomes, expectations of others, and information about issues of control (Ajzen & Fishbein, 2005), it is only scarcely mentioned via the influence of background factors such as individuals' past behaviour. To apply the RAA within a time-dependent agricultural context we, therefore, face several design challenges. First, RAA makes a clear distinction between personal beliefs, i.e., the attitude, and socially influenced beliefs, i.e., the subjective norm. Studies have shown, however, that over time, attitudes change partly through social influence processes and situational factors (Gawronski & Bodenhausen,

2006; Petty & Wegener, 1998; Wood, 2000). This means, that over time, social influence is modelled twice, while in the model we would like to keep the level of the individual apart from the level of the group. Second, researchers have argued that, dependent on context, RAA can be improved by introducing new variables to the prediction of behaviour (Fielding, Terry, Masser, & Hogg, 2008; Martin Fishbein & Ajzen, 2010). Social influence from reference groups is important for understanding farmer behaviour (Beedell & Rehman, 2000; Burton, 2004; Edwards-Jones, 2006), and enrichment of the social influence construct of RAA improves the predictive capacity of the model (Fielding et al., 2008). Third, RAA leaves space for the operationalization of feedback mechanisms, i.e., the consequences of other's past behaviour on current individual decision-making, and the influence of societal structure.

2.3.2 INNOVATION DIFFUSION RESEARCH

To distinguish between on the one hand social influence processes, and on the other, personality and situational factors, we turn to innovation diffusion research. Innovation diffusion research has shown that innovativeness is an important aspect, with innovativeness reflecting the degree to which an individual is early in adopting new ideas relative to other members of a system. Innovative individuals are more capable to cope with uncertainty and risk, less dogmatic, and more open to new experiences, among other things. Communication between people that differ in innovativeness is key to innovation diffusion (Rogers, 2003). In our model innovativeness refers to the degree to which an individual makes original decisions independent of other factors, and is therefore seen as a permanent personality characteristics (Vishwanath, 2005). Another important aspect is the relative advantage of an innovation, defined as "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003). This is often expressed as economic profitability. Economic profitability can include financial aspects, but also status aspects. In the model economic profitability is defined by expected financial gains or losses, because status aspects are already covered by social influence, and financial aspects have proven to be important in farmer decision-making (Brudermann, Reinsberger, Orthofer, Kislinger, & Posch, 2013; Mandryk, Reidsma, Kanellopoulos, Groot, & van Ittersum, 2014).

2.3.3 SOCIAL INFLUENCE

To enrich the social influence construct of RAA we turn to identity theory. Identity research looks at the relation between the construction of an individual's self-concept, i.e. "Who am I?", and the individuals' behaviour. There are two main theories that define the social part of the individual based on the self-concept and the influence of reference groups on individuals' behaviour: identity theory and social identity theory. Identity theory is concerned with predicting role-related behaviours, e.g. father, farmer, or citizen, and defines identity as a relative stable factor that drives behaviour (Burton & Wilson, 2006; Hogg et al., 1995). On the other hand, social identity theory is concerned with describing the relation between social aspects of the self-concept and behaviour that results from intergroup relations and group processes, such as ethnocentrism, stereotyping, conformity, collective action and group solidarity (Fielding et al., 2008; Hogg et al., 1995). In contrast with identity theorists, social identity theorists argue that identity is dynamic and context specific (Hogg et al., 1995). A common ground in both theories is that they define identity as comprised of multiple identities with their respective reference groups, in which the reference groups guide the individual's behaviour through expectations that are associated with being a member of a specific group (Burke & Reitzes, 1991; Hogg et al., 1995). Thus, an individual is motivated to act within the socially appropriate boundaries of a specific reference group to maintain one's self-concept in the eyes of others and confirm one's status as a group member (Burton & Wilson, 2006; Cialdini, 2009; Hogg et al., 1995). Via commitment to reference groups the individual establishes a hierarchy of identities within one's self-concept. The identity that is most salient and guides behaviour is the identity to which the individual has the highest commitment (Burke & Reitzes, 1991; Callero, 1985). The most important difference between the subjective norm of the RAA and social influence seen from an identity perspective, is that identity approaches argue that norms are linked to specific reference groups instead of the summarized norms of generalised important others, and, that some reference groups influence behaviour more strongly than others, based on the commitment hierarchy in an individual's self-concept (Burton, 2004).

Farmers' self-concepts reflect farmers' definition of being a good farmer and serve as a basis for action (Bryant, 1999; Burton & Wilson, 2006; van der Ploeg, 1993). Many studies have represented heterogeneity in good farmer definitions and related farming practices as farming typologies or farming styles (Commandeur, 2006; de Rooij et al., 2010; van

der Ploeg, 1993; Vanclay, Howden, Mesiti, & Glyde, 2006). Although different authors give different names (Burton & Wilson, 2006; Commandeur, 2003, 2006; de Rooij et al., 2010), generally farmers can be categorised as (Burton & Wilson, 2006): the traditional farmer, or craftsmen, focusing on production results and stewardship; the agribusiness farmer, or expansionist, focusing on competition and profit; the conservation farmer, or idealist, focusing on the environment and life-style concerns; and the diversifier, shifting his focus away to non-farming activities as sources of income (Burton & Wilson, 2006; Commandeur, 2003; de Rooij et al., 2010). De Rooij et al. (2010), developed a typology of Dutch pork farmers based on their ethical positions towards animal welfare; they pointed at the emergence of new types in reaction to pressures from animal welfare NGO's and consumers (de Rooij et al., 2010).

Studies have shown that farmers' self-concepts and related farming practices are fairly resistant to change (Burton & Wilson, 2006; Commandeur, 2003; Maes & Passel, 2014; van der Ploeg, 1993). The study by Maes and Passel (2014), for example, showed that a resistance to change at farm level could explain the evolution of Belgium agriculture. They assumed heterogeneity in farming types as a basis for decision-making, rather than profit-maximisation (Maes & Passel, 2014). Burton and Wilson (2006) showed that policy incentives that tried 'to encourage farmers away from dependency on productivist roles towards becoming independent leisure providers, conservation managers and diversified businesspersons', have failed because of farmers' commitment to their identity as producers. Another study by Watkins et al. (1996) that looked into Community Forests reported a strong farmer resistance to adopt woodlands on their farm, because farmers did not identify themselves as foresters and found it hard to convert agricultural land, which took time and effort to make it cultivable, into forests. Thus, farmers' salient identity is a relative stable factor that drives behaviour. Note that identity and its reference groups can inhibit as well as precipitate change, as mentioned in the introduction.

In the framework we replace the term Subjective Norm with Social Influence, to include the influence from reference groups next to the normative influence from 'important others' as defined by the Reasoned Action Approach. Influence from reference groups include influence from the identity specific reference group determined by the farmers' salient identity (Figure 2.2.).

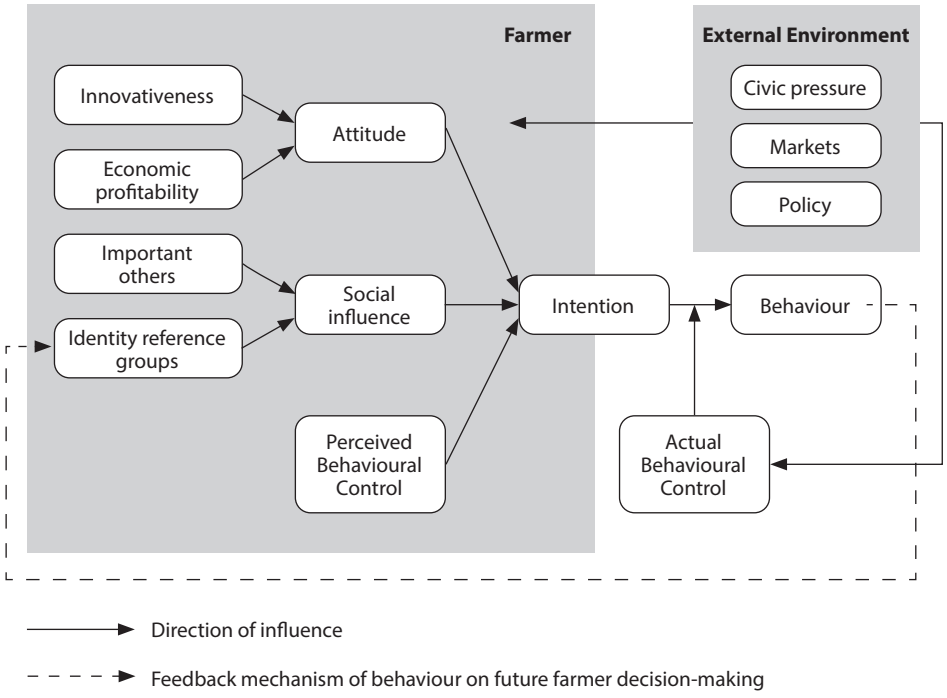

FIGURE 2.2. Theoretical framework of farmer decision-making

2.3.4 THEORY OF STRUCTURATION

To allow for feedback mechanisms in RAA and the inclusion of societal structure influence on decision-making, we include the Theory of Structuration (Giddens, 1984). Its central element is the balanced relation between agency, i.e., what is in the power of the human being itself, and structure, i.e., what is shaped by the institutional environment. Within a given context humans have a certain space for manoeuvre. The options available to humans are shaped by societal structure, but only momentarily. Structure shapes action, and action shapes structure. How structure shapes action is dependent on the individual agent, and is, therefore, a proof of agency (Baber, 1991).

One way to feedback previous actions of farmer reference groups into current decision-making of individuals is to look at the influence of proportions in a given population. This means that the bigger the proportion of a minority group within a population, the more likely its influence balances out the previously dominant group (Moss Kanter, 1977).

Research on the influence of proportions in a population showed that when minorities occupy less than 20% of the total population, intergroup dynamics, such as visibility of the minority group, polarization and stereotyping occur (Moss Kanter, 1977). Societal structure is given by the external environment and represents the influence of markets, civic criticism, and policy intervention (Figure 2.2.).

2.4 RESULTS SEMI-STRUCTURED INTERVIEWS

The interview results are categorised according to the constructs defined by the theoretical framework. For each construct the relevant background factors are discussed. We finalise with an improved framework of farmer decision-making.

2.4.1 ATTITUDE

2.4.1.1 INNOVATIVENESS

All experts mentioned the importance of farmers' personality traits. They pointed at the conservative nature of farmers, illustrated by statements such as: "the number of farmers who would deviate from what is minimally required by law is low. The majority of farmers have the ambition to expand their farm and fulfil to government requirements", and "for most farmers, producing for the intermediate market is a big step, because it requires a different way of thinking", meaning that farmers first have to increase cost price to obtain higher prices for their products, which contradicts current cost-price reduction strategies. The responses of three farmers confirm the image of conservative farmers; in their view the organic market is not meant for them and not something they consider. According to three experts, the innovative nature of farmers is characterized by their openness to societal developments and their orientation towards the market. The innovative nature of one farmer was illustrated by his choice to produce for an added-value market developed by a cooperation of other farmers that is open to suggestions and co-development, instead of choosing "to conform to market requirements made by existing institutions". That same farmer mentioned production of a distinctive product and communication with other farmers as two positive aspects of added-value markets.

2.4.1.2 ECONOMIC PROFITABILITY

Economic profitability plays an important role in two ways. First, according to three experts, economic pressure in the conventional market, due to volatile commodity markets and new government requirements, has stimulated farmers to consider added-value markets. Second, according to all experts and farmers, expected economic benefits determine whether an added-value market is financially attractive to adopt. Three experts argued that intermediate market conversion is mainly an economic consideration. Two farmers approached their accountant to calculate whether they would financially benefit from adopting the intermediate market. Both had negative results. Furthermore, all farmers point out that if they were certain that an innovation leads to higher financial returns, they would change.

2.4.2 SOCIAL INFLUENCE

All experts mentioned advisors and other farmers as influential in the decision-making process. Two experts mentioned civic influence as an influential reference group.

2.4.2.1 IMPORTANT OTHERS

The slaughterhouse advisor, accountant, feed provider, and veterinarian visit the farm regularly. They are often the first with whom farmers discuss their ideas. For example, accountants calculate the economic benefits of a potential market change or strategy. If they are negative, farmers are not likely to change their farm practices. Current stakes can also play a role: feed advisors might be able to sell less feed to farmers who decide to have fewer pigs in their housing system. Advisors can also trigger new ideas. For example, accountants, who worked together with slaughterhouse advisors, approached the first farmers to produce for the intermediate market. The advisors knew the farmers well and took their entrepreneurial profile into consideration when searching for candidates. They searched for farmers who were oriented towards the Dutch market, open to new ideas, and relatively active in farmer associations. The importance of the slaughterhouse advisors was also mentioned in interviews with farmers. The organic pig farmer, for example, was tipped by an organic slaughterhouse advisor to consider organic farming as a future alternative.

2.4.2.2 IDENTITY REFERENCE GROUPS

The factors that determine the level of influence from the farmer identity reference group are 1) similarity in identity, 2) normative influence, and 3) leadership. The first factor was mentioned by farmers and experts. Around 10 years ago, a stigma on organic farmers existed. One farmer mentioned that organic farmers were less entrepreneurial with little energy for change and innovation. This farmer, therefore, chose not to convert. Three experts confirmed this stigma: organic farmers were idealists, non-professional, and opposed conventional farming; they had small-scale farms, could not keep up with scale-enlargement, and turned to organic farming out of necessity. This perception has changed over the years, but according to one expert, many farmers still view organic farmers this way. The second factor, normative influence, was felt by one farmer when other farmers rejected his new ideas. Two experts confirmed the difficulty farmers experience when developing and implementing a novel idea. Finally, three experts mentioned the importance of leadership. Farmers who are well known in the farmer community, through e.g., active participation in farmer organisations, have more influence on the acceptance of added-value markets or technology than other farmers. The slaughterhouse advisors of the intermediate market consciously approached farmers with a leadership role to stimulate acceptance in the farmer community.

2.4.2.3 CIVIC INFLUENCE

All farmers mentioned that they experience pressure to change farming practices from three main groups outside the farming community: 1) animal welfare NGO's, 2) consumers, and 3) retailers. Five farmers believe that added-value markets improve the image of the pork sector. One expert mentioned that some farmers who switched to the intermediate market did so because they felt responsible for the image the pork sector has in society. Most farmers, however, do not consider changing; they view civic society as an out-group and/or believe criticism comes from a small group of people.

2.4.3 PERCEIVED BEHAVIOURAL CONTROL (PBC)

All experts point at the importance of farm resources that determine whether changing markets is economically viable and physically possible, and to the importance of external and institutional factors, defined by markets and policy that determine whether changing markets is perceived possible.

2.4.3.1 FARM RESOURCES

All experts mention that farm resources determine whether a farmer can change markets. Path dependency, due to previous investments in bulk production and economies of scale, makes conversion hard for some farmers. Housing systems, for example, have a lifetime of 30 years and can be rebuilt on average every 15 years. Furthermore, the intermediate and organic markets are both small compared to the conventional market. One farmer mentioned that the volume of the Dutch intermediate market is too small for him to consider conversion.

2.4.3.2 ADDED-VALUE MARKETS

Added-value markets influence the perceived behavioural control through 1) demand, 2) certification requirements, and 3) trust in long-term viability of the market.

All experts and farmers mentioned the importance of consumer and retail demand. Two experts argued that previous attempts at pork meat differentiation have (partly) failed due to a lack in consumer and/or retail demand. Furthermore, according to one expert, the success of the organic market, just after the swine fever outbreak in 1997, was partly due to an increase in demand from retail. Consumer demand, however, was overestimated, and as a result some organic farmers have quit organic pork production or have gone bankrupt due to over-supply. The cooperation of farmers at the slaughter company, who process around 95% of organic pork, now regulate supply through waiting lists; 3-5% of organic farmers organise their own sales. Other factors that boosted the organic market late '90s, were professionalization of the market due to EU regulation for organic production, involvement of a slaughterhouse that centralised organic pork processing, and a policy stimulation measure.

All experts mentioned the influence of market certification requirements. For conventional farmers to switch to the organic market, large-scale certification requirements are coupled with large investments supported through expected higher meat prices. This makes it hard to switch back to the conventional market after investments have been made. Furthermore, it can take up to four years before all permits and loans are organised. To get access to the intermediate market small-scale changes are generally needed, e.g., the maximum number of pigs per pen. This leaves the possibility open to switch back to the conventional market in the future.

All farmers and experts mentioned that trust in retailers is low concerning the intermediate market. They argue that supermarkets and buyers of added-value pork meat promise the customer a similar price for pork meat even though the cost price has increased. This is regarded by many farmers as unfair. Furthermore, three pork farmers doubt the long-term viability of the intermediate market, due to possible lack of interest from retail in the future or to a possible government intervention that introduces new law requirements similar to those set by the intermediate market. Previous experience feeds the lack of trust in long-term viability of added-value markets; e.g., a qualification scheme to improve the position of Dutch pork farmers in the international market developed into a norm.

2.4.4 ACTUAL BEHAVIOURAL CONTROL

The factors that determine whether a willing farmer is actually able to change markets are 1) bank loans, 2) permits and 3) waiting-lists. Banks look at technical results, yield, current funding, and the entrepreneurial profile. National law and provincial regulations define permit procedures. Waiting-lists are controlled by slaughterhouses based on expected demand.

2.4.5 THEORETICAL FRAMEWORK WITH INTERVIEW RESULTS

Results of interviews point at possible mechanisms of social influence and the importance of identity reference groups. They also point at possible path dependency via farm resources as a result of previous decisions in housing system development. Furthermore, the interviews show that external environmental factors influence 1) economic profitability via economic pressure in the conventional market and expected economic margin of added-value markets, 2) social influence via injunctive norms of consumers and animal welfare NGO's, 3) perceived behavioural control via added-value market demand and requirements, and trust in policy and added-value markets, and 4) actual behavioural control via permit procedures, bank loans and market waiting lists (see Figure 2.3.).

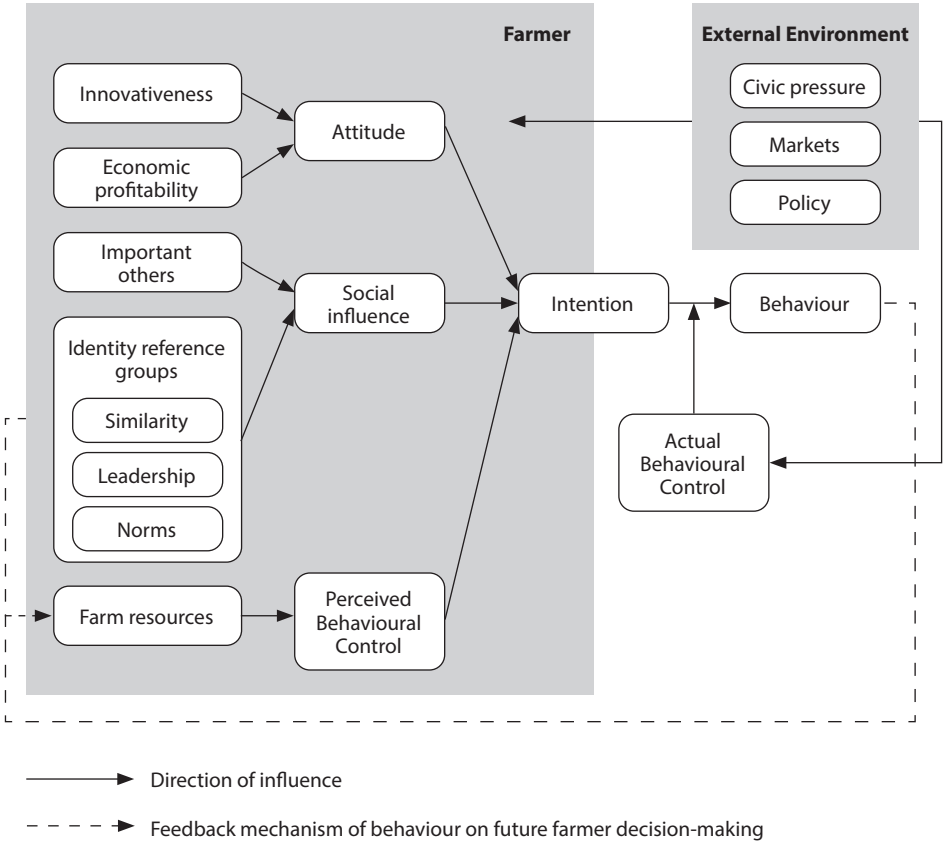

FIGURE 2.3. Theoretical framework of farmer decision-making improved with interview results

2.5 DISCUSSION

2.5.1 METHOD

In this research we developed a theoretical framework of farmer decision-making that is grounded in theory and tested and improved through semi-structured interviews. In this framework we conceptualised 1) a clear distinction between different factors of decision-making, 2) social influence mechanisms linked to identity reference groups, 3)

feedback mechanisms, and 4) societal structure that determines the space for manoeuvre. We operationalised and quantified social influence factors and feedback mechanisms by using proportions for descriptive norms linked to identity reference groups, and by using commitments to farmer reference groups for determining the influence of each. Furthermore, the framework conceptualised aspects of social influence that were discussed in interviews with pork farmers and experts. These interviews verified the importance of innovativeness, identity types and reference groups for understanding which farmers may be expected to adopt an added-value market. Besides, the interviews pointed towards 1) economic factors, 2) possible mechanisms of social influence from farmer reference groups, 3) path dependency in farm resources as a result of previous decision-making, and 4) context specific factors. Experts particularly clarified social influence mechanisms, while both experts and farmers highlighted the importance of context specific factors, with a strong focus on retail and consumer demand and trust in retail and government. This framework differs from the framework by Feola and Binder (2010) in that it specifies and quantifies social influence mechanisms related to farmer specific reference groups. Furthermore, personality is included, as opposed to the emotional system of an individual, while physiological arousal and habit are not included.

2.5.2 GENERALIZABILITY

We tested and improved the farmer decision-making framework with regard to one case study: Dutch pork farmer decision-making of added-value market adoption. Some factors are likely to be applicable in a variety of case studies, while context specific factors need to be assessed for each behaviour. The interviews appointed well known social influence mechanisms in sociology and social-psychology: similarity, leadership and norms (Brown, 2000; Cialdini, 2009), and are therefore likely to be applicable in a variety of cases even outside the agricultural sector. The factors related to the context of innovation adoption with medium to long-term consequences for the farmer, such as innovativeness, economic profitability, and farm resources are likely to be important for other cases of farmers' strategic decision-making, although the weights per factor might vary. The context specific factors that determine the weights per construct differ per situation.

2.5.3 DYNAMICS

Because the framework distinguishes different factors of decision-making, allows for feedback mechanisms via collectives, and includes the external environment, via economic and institutional factors, it allows to study how decision-making influences sector behaviour, given path dependency and dynamics as a result of previous decision-making. Furthermore, sector behaviour can be operationalised by identifying perceived sustainability indicators of relevant stakeholders. With the framework we can, therefore, investigate questions of how social influence related to reference groups affects sustainability indicators (Burton & Wilson, 2006; Edwards-Jones, 2006), how institutional changes influence farmer behaviour given the social structure in which farmers are embedded (Squazzoni, 2012), and how previous decisions of farmer behaviour affect adaptation to institutional changes. In other words, with the framework we can gain greater insight in how agency affects structure and how structure affects agency.

2.5.4 FUTURE RESEARCH

A meaningful tool to further operationalise the framework and explore these questions is agent-based modelling (ABM). The aim of ABM is to abstract those mechanisms that might be responsible for system behaviour through selective simplification (Squazzoni, 2012). Several simulation studies have explored mechanisms of social influence and its impact on innovation diffusion within agriculture (Deffuant et al., 2002; Kaufmann et al., 2009; Schreinemachers et al., 2009). None of them, however, has looked at the Dutch pork sector in particular. Exploring the relation between on the one hand farmers' reaction to institutional changes, and on the other emergent pork sector sustainability indicators, is interesting for researchers, and when used to explore the effect of different policy scenarios, interesting for policy makers.

2.6 CONCLUSION

This research showed a time-dependent and integrated framework to model farmer decision-making. Theory and previous research helped to focus on important constructs of farmer decision-making, while interviews, apart from confirming the constructs defined by the theoretical framework, pointed at possible feedback mechanisms of path dependency and social influence dynamics. These mechanisms can result in unexpected macro dynamics. To gain further insight in how farmer decision-making influences sector developments we discussed agent-based modelling as a promising tool.

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CHAPTER 3

THE SOCIAL INFLUENCE OF INVESTMENT DECISIONS: THE CASE OF THE DUTCH PORK SECTOR

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Livestock Science 220 (February), pp. 111-122

ABSTRACT

Policy makers and researchers foresee four investment strategies for conventional pig farmers in contested pork production regions: 1) continue with a cost-price reduction strategy through modernisation and scale enlargement; 2) convert to an intermediate market segment with higher requirements as to animal welfare and environment than conventional; 3) convert to a niche market segment with higher requirements as to animal welfare and environment than intermediate; or 4) quit farming. For policy makers, it is interesting to gain insight in intensive livestock farmer's perceptions regarding these investments and in processes of social interaction that influence farmer decision-making and the potential diffusion of investment strategies over time (Edwards-Jones, 2006). The aim of this explorative study is to analyse the effect of social interaction on diffusion of investment strategies in capital-intensive livestock production systems with groups of Dutch pig farmers, using a simulation game. The game is designed in such a way that contextual factors do not provide a limiting factor. Furthermore, the game is constructed to stimulate interaction and to trigger imagination of participants. Our main research questions for the analysis of the results of the game sessions were: (1) 'what are differences in diffusion of investment strategies between sessions?', and (2) 'to what extent does social interaction affect diffusion of investment strategies?'. A total of seven sessions were played, with 4-8 pig farmers and/or participants who were affiliated to the sector as advisor or successor. All game sessions were video- and voice- recorded, and interaction between participants was transcribed per game session. First, differences in diffusion of investment strategies between sessions were explored. Second, the causes for differences in diffusion between sessions were explored, by looking at the type of investment strategy, communication between participants, and processes of influence. Special attention was given to the influence of opinion leadership. The results of this research show that (1) only investment strategies with a financial benefit did, under influence of social interaction, result in high adoption; (2) for high adoption to occur, communication between participants was necessary; (3) opinion leaders

played an essential role in high adoption of investment strategies; and (4) there was a common understanding among participants that favoured scale enlargement. The gaming methodology triggered participants to communicate their tacit knowledge, i.e., assessment criteria that are important in real-life investment decisions, and to experiment with investment strategies.

Keywords: farmer decision-making, simulation games, innovation diffusion, social influence, opinion leadership, role-playing games.

3.1 INTRODUCTION

The Netherlands has more pigs than people in some provinces (CBS, 2018). In these concentrated intensive livestock production regions citizens and policy-makers are currently dealing with the negative side-effects of production: e.g. bad air quality; increased risk for zoonoses; and decreased landscape quality (Coenraadts & Cornelissen, 2011; Hendrickson & Miele, 2009; Jansen, Douma, Hoogeveen, Huirne, & Rosenthal, 2016; Osterberg & Wallinga, 2004; Pitcairn et al., 1998). At the same time, farmers deal with pressure on their income due to volatile market prices and high production costs (Greef & Casabianca, 2009). To tackle these problems, farmers need to change production methods. Researchers and policy makers envision four investment strategies for them (Backus & Schans, 2000; Den Ouden, Dijkhuizen, Huirne, & Zuurbier, 1996; Greef, Maathuis, & Casabianca, 2008; Provincie Noord-Brabant, 2017): 1) continue with a cost-price reduction strategy through modernisation and scale enlargement to stay competitive in the international market. Modernisation should increase societal acceptance by reducing environmental pressure and improved animal health through innovations. 2) Switch from conventional production to an intermediate market segment. The biggest in the Netherlands is the '1-star better life' (*1 ster beter leven*) concept established by the Animal Protection Society. In this concept pigs have, among other things, 1 m^2 of living space instead of 0.8 m^2, extra distraction material, and males are not castrated (Dierenbescherming, 2018). This switch constitutes a reversible investment, as it requires extra investment in inventory only (Gocsik, Oude Lansink, Voermans, & Saatkamp, 2015). 3) Switch to a niche market segment. The best-known niche segment is the organic market, which has the maximum score of three stars from the Animal Protection Society. In this concept pigs have, among other things, outdoor access, a total living space (indoor plus outdoor) of 2.3 m^2 per pig, and straw bedding instead of a concrete floor (Dierenbescherming, 2018). It is an irreversible investment, i.e., it requires investment in both building and inventory. The possibility to invest therefore depends on depreciation of current stables and the related investment rhythm of the farm (Gocsik et al., 2015). 4) Quit farming. Currently, the majority of farmers follow the cost-price reduction strategy and produce for the conventional market (mostly for export), while the intermediate and niche markets, the more innovative investment strategies, are regarded as a more societally acceptable farming practice (Gocsik, Oude Lansink, et al.,

2015; Greef & Casabianca, 2009). For policy makers in concentrated livestock production regions who have to manage the negative external effects of livestock production, it is interesting to gain insight in perceptions of famers with intensive livestock production regarding these investments and in processes of social interaction that influence their perceptions and the potential diffusion of investment strategies over time (Edwards-Jones, 2006). This gives policy-makers a better basis for developing policy interventions.

Factors related to strategic investment decisions of livestock farmers can be grouped in three categories (Ambrosius, Hofstede, Bock, Bokkers, & Beulens, 2015): 1) contextual factors, i.e. factors external to the person, such as farm resources, market price dynamics and policies; 2) factors related to the person, such as farmer's personality, individual considerations and demographics; and 3) factors related to the farmer in relation to her/his social environment, i.e. influence as a consequence of social interaction, such as social learning and conformity.

Previous studies found that contextual factors, i.e. factors external to the farmer, are dominant in the reasons farmers address inhibiting them from choosing market differentiation (Ambrosius et al., 2015; Gocsik, van der Lans, Lansink, & Saatkamp, 2015). The ability to invest, for example, is limited by legislation policies and current farm resources (De Lauwere, van Asseldonk, van 't Riet, de Hoop, & ten Pierick, 2012), while the expected financial security of added-value markets is influenced by expected policies and certainty of price premiums (Ambrosius et al., 2015; Gocsik, 2014; Greiner & Gregg, 2011; Pannell et al., 2006). Furthermore, larger farms are associated with a higher probability to invest in scale enlargement (Oude Lansink, van den Berg, & Huirne, 2003). Studies that focused on factors related to the person, e.g. farmers' individual considerations and demographics, found that farmers differed in their willingness to convert to markets with higher requirements for animal welfare given the same expected income (Gocsik et al., 2015); that a positive attitude towards the environment is needed for the decision to build a more sustainable stable (Kemp, Nijhoff-Savvaki, Ruitenburg, Trienekens, & Omta, 2014); and that risk averse farmers focus on optimisation of current production processes instead of increasing farm size (Oude Lansink et al., 2003). In addition, Oude Lansink et al. (2003) found that the farmer's time horizon, i.e. his age and presence of a successor, is an important in the probability of the farmer to have plans to invest.

Research so far has rarely considered the third dimension, i.e. the farmer's social environment (Burton, 2004; Burton & Wilson, 2006; Edwards-Jones, 2006; Ghadim,

Pannell, & Burton, 2005), while social experiments showed that normative social influence is an important (subconscious) factor that influences decision-making (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). Recent empirical studies support that farmers' social interaction behaviour is indeed related to their decision-making (Aguilar-Gallegos, Muñoz-Rodríguez, Santoyo-Cortés, Aguilar-Ávila, & Klerkx, 2015; Hunecke, Engler, Jara-Rojas, & Poortvliet, 2017; Micheels & Nolan, 2016; Tepic, Trienekens, Hoste, & Omta, 2012). The study by Tepic et al. (2012) for example, which focused on pig farmer behaviour, showed that high network frequency with pork sector stakeholders is related to adoption of sustainable farms. An important mechanism through which social interaction influences decision-making is opinion leadership. Opinion leaders within a group are members who exert "an unequal amount of influence on the decisions of others" (Rogers & Cartano, 1962). They have a visible position within a large network and can thereby remove barriers to change with novel opinions, increasing the diffusion of innovations (Li, Ma, Zhang, Huang, & Kinshuk, 2013). Note that opinion leaders within conservative networks are found to be less innovative than those in innovative networks (Rogers & Cartano, 1962), and can therefore also inhibit change. Opinion leaders exert influence through social learning, social influence and/or coordination. Social learning means that farmers learn from the experience and/or opinion of others and can profit from a decreased uncertainty and higher pay-offs (Flynn, Goldsmith, & Eastman, 1996; Young, 2009). Social influence of an opinion leader is established through his/her reflection of the norms that are prevalent within the social group. The desire of other group members to be a member of the group is the driving force behind opinion change (Flynn et al., 1996). Coordination means that an individual tries to guide people to work together to solve a collective action problem (Calvert, 1992; Malone & Crowston, 1990). All in all, given that farmers when interviewed mainly point to contextual factors, while social interaction has proved to be of influence, it would seem that farmers are unaware of social influences, unwilling to reveal them, or both. More research into the effect of social interaction on the decision-making process and related diffusion of investment strategies is important. Methods that capture social interaction and diffusion processes at the same time need to be explored.

A promising method is the use of simulation games (Anderies et al., 2011; Barreteau, Bousquet, & Attonaty, 2001; Hofstede, de Caluwé, & Peters, 2010; Susi, Johannesson, & Backlund, 2007). A simulation game is a game in which participants have the option to

individually and/or collectively make purposeful decisions that have consequences for individual and groups' resources (Hofstede et al., 2010). Simulation games are referred to as games in the remaining article. Games provide an experimental setting that can grasp the complexity of a real-world system, while offering a higher degree of control over several variables compared to a real-world system (Anderies et al., 2011). Games differ in complexity with respect to real-world cases, openness in behavioural responses and selection of participants (Speelman, García-Barrios, Groot, & Tittonell, 2014). Games designed with correspondence to the real world have the ability to derive information about behaviour in a contextualised environment (Anderies et al., 2011). A gaming environment, furthermore, has the ability to derive information about behaviour, which might have been hard to derive from individual interviews (Vieira Pak & Castillo Brieva, 2010). This type of game is often played with participants who are real actors in the given context to remind them of their own situation (de Caluwé, Hofstede, & Peters, 2008; Meadows, 2001b). Games, therefore, can be an effective method to observe behavioural responses of participants to particular scenarios within a specific context (Bousquet et al., 1999). They have also been promising in gathering information on possible effects of social interaction on decision-making: e.g. one game observed that existing norms influenced behaviour in the game (Villamor & Noordwijk, 2011), and Speelman et al. (2014) showed that it was possible to identify leaders in game sessions who could serve as role models for other participants in the session (Speelman et al., 2014). All in all, to gain a better understanding of the effect of social interaction on farmer decision-making and related diffusion of investment strategies, it is important to create a setting that frees pig farmers from contextual constraints that, currently, negatively influence the expected financial benefit of market differentiation. A simulation game provides a promising method to create a realistic, yet simple, experimental environment for this purpose. The previous game studies that indicated effects of social interaction in game settings were pioneering in nature. This study adds to these pioneering studies by building on and further developing methods for the analysis of social interaction in game data. The main research questions addressed for the analysis of the game sessions were: 'What are the differences in diffusion of investment strategies between game sessions?' And 'To what extent does social interaction influence the diffusion of investment strategies in the game sessions?'

The remainder of this article is organized as follows. In the methods section, the process of game design, game description, game participants, as well as the methods used to analyse game results, are described. This is followed by an analysis of the results of the game sessions. In section 3, the findings are discussed and the method used is elaborated upon. The article ends with some final reflections and suggestions for future research.

3.2 MATERIAL AND METHODS

3.2.1 FROM CASE STUDY TO GAME DESIGN

We designed the simulation game according to the following guidelines: (1) the game should be able to trigger imagination and exploration of the participants in order to relate participants' decision-making in the game to decisions in real-world scenarios (Meadows, 2001a); (2) it should encourage social interaction between participants; and (3) the game should be playable and the pork sector case should be simplified in such a way that the game can be easily communicated and understood (Villamor & Noordwijk, 2011).

TABLE 3.1. Game incentives: costs and change in acceptance scores of investments, compared to conventional

	Type of costs						Δ AS
Market investments	**Rebuild (per stable)**			**New Stable**	**Yearly (per stable)**	**Once (per farm)**	**Acceptance score points**
↓ Convert from: → Convert to:	**(A)**	**(B)**	**(C)**				
Conventional (A)		1000	15000	20 000	-	-	-
Intermediate segment (B)	0		14000	20 000	1 000	-	+ 1
Niche (C)	15000	14000		20 000	2 000	-	+ 3
Small investments	**Rebuild (per stable)**			**New Stable**	**Yearly (per stable)**	**Once (per farm)**	**Acceptance score points**
Straw stable	1 500			-	500	-	+ 2
Vista stable	-			-	-	1 500	+ 1
Course pig signals	-			-	-	500	+ 0.5
BANK	**Maximum loan**			**Yearly costs for rent**		**Yearly repayment**	
Loan	15 000			500		1 000	

A realistic representation of the pork sector in the game was designed in collaboration with an economist specialised in the pork sector and with sons of pig farmers. The current situation in the pork sector was taken as a starting point for game design. Each participant, therefore, starts with two conventional stables (see Figure 3.1.) and can choose between the two strategic investment decisions described in the introduction (we leave out quitting): 1) a cost-price reduction strategy through scale enlargement, i.e., by investing in an extra stable (see Table 3.1.), and 2) a market differentiation strategy through creating added-value by investing in either an intermediate market segment or a niche market segment. The intermediate market represents the one-star better life concept and two fictional intermediate market segments are introduced during the game, i.e., the local and supermarket segment described below. The niche market represents organic farming. Economic pressure is represented through fluctuation in market prices in these three market segments, i.e., conventional, intermediate and niche. In the conventional market, price fluctuations are known to go from high to low influenced by changes in supply and/or demand in the world market (Holst, von Cramon-Taubadel, Cramon-Taubadel, & Holst, 2012). Supply and demand in the European market are, apart from being influenced by the production volume of farmers, influenced by external shocks, such as an increase or decrease in demand from China or a boycott on European pork meat from Russia. In the game, fluctuations in conventional market prices are fixed and, therefore, the same in each game session. Participants are informed by large changes in prices through predetermined external shocks that are announced at the start of each round. In the game, price fluctuations in the intermediate market correspond to conventional price fluctuations, while the extra costs that farmers make for producing for the intermediate market are discounted. Price fluctuations in the niche markets are known to be sensitive to small changes in demand and supply and, therefore, volatile. In the game, price fluctuations in the niche market are influenced by fixed fluctuations in demand and by the total supply in the game, i.e., the combined production volume for the niche market of all participants. Price fluctuations in the niche market can, therefore, be different per game session. To increase playability of the game, extra 'smaller' investment options for players were added on top of the strategic investment decisions: a vista stable (a stable designed to welcome visitors), a straw stable (a stable that provides for exploring needs of pigs) and a course to learn more about pig behaviour, i.e., a course in pig signals (see Table 3.1.). The vista- and straw stable require adaptations to conventional stables,

through either rebuilding of all current stables (i.e., straw stable) or rebuilding of one stable (i.e., vista stable). None of the extra investments are related to an added-value market segment and increased costs are, therefore, not repaid through the market. Societal acceptance is represented by a sector acceptance score. The sector acceptance score is a measure of the sector's reputation, treated as a common pool resource for the farmers. It is modelled as a number between zero (extremely negative) and ten (extremely positive). It is calculated by the average of participants' individual acceptance scores. If the sector acceptance score is below six, the image is negative and the probability of stricter policy (i.e., obliged investments) and NGO campaigns (i.e., a worse acceptance score) increases. If it is six or above, the image is positive, and the probability of stricter policy and NGO campaigns decreases.

To stimulate interaction between participants and create room for the emergence of opinion leaders and followers, participants are 1) given the chance to individually or collectively invest in a chance card (further explained below) to increase the sector acceptance score, and 2) given extra cooperation moments during the game through the introduction of two extra intermediate segments for which a minimum of participants are needed: the local market and supermarket segment. The local market segment requires an investment in a straw stable and prohibits investing in an extra stable, is introduced at a time when conventional market prices are high. The supermarket segment requires an investment in an air scrubber to reduce ammonia and fine particle emissions, and an investment in a straw stable to improve animal welfare by providing a thick layer of straw for pigs as exploration, distraction and rooting material. The supermarket segment is introduced at a moment when prices are low. The market price fluctuations of both local market and supermarket follow the same rules as the intermediate market: conventional market fluctuations with a compensation in cost price.

Finally, simplification of the game was realised through a focus on strategic investment decisions, i.e., scale enlargement and market differentiation. This choice left out short-term managerial investment decisions and technical performance. The playability of the game was tested and improved through pilot sessions with students and sons of pig farmers. The first session with farmers and advisors was used for data gathering as well as a final pilot session. The game was adjusted where necessary to improve playability and data gathering (see Appendix 3.A.). The first session, therefore, differed from the other sessions.

3.2.2 GAME DESCRIPTION

The game is played with 4 to 8 participants, consists of rounds that represent one year, and is played for either 10 rounds or a maximum of 1.5 hours including two trial rounds. In the remaining article we mean with game session, also referred to as session, one game from start till finish, existing of a maximum of 10 rounds, played by one group of participants. When there are one or two rounds left, the game facilitator announces this to the participants.

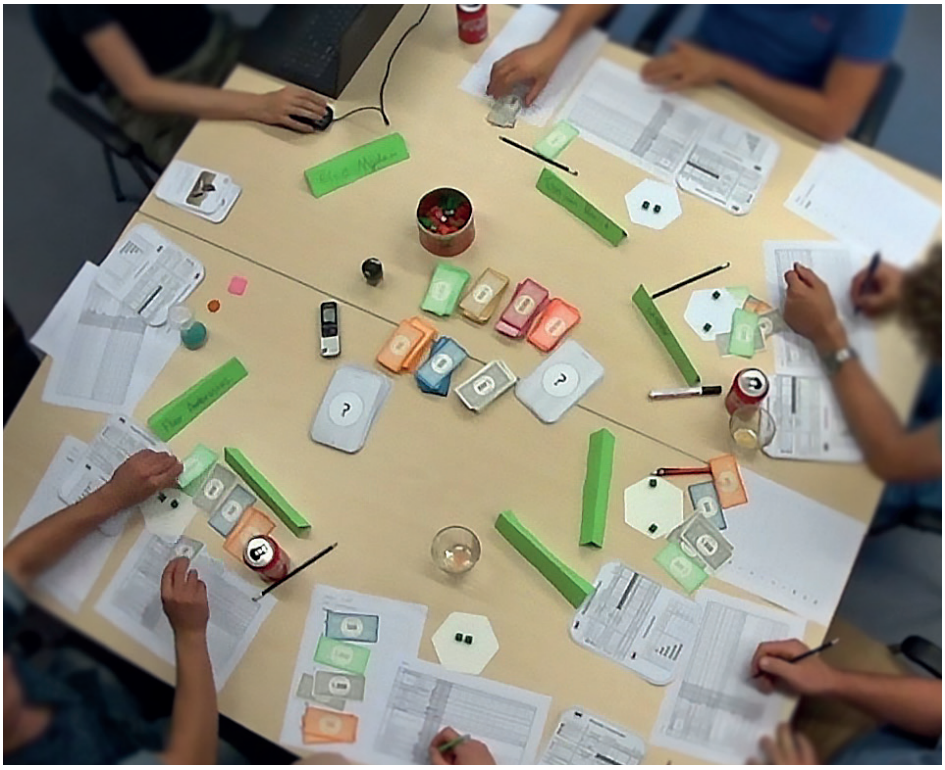

FIGURE 3.1. the start of a game session with participants

Participants are given two goals: 1. to financially manage their farm to avoid bankruptcy, and 2. to collectively manage the sector acceptance score. Each participant starts with two conventional stables, 5 000, - units of capital (no official currency), and an individual acceptance score of 6. Figure 3.1. gives an impression of the start of a game setting. With their capital, participants can buy the following investments: convert to another market segment, make additional investments on the current farm, and/or invest in scale enlargement by buying an extra stable. Investments differ in the type of costs and in their effect on individual acceptance scores (see Table 3.1.). An extra stable gives participants a fixed and known financial advantage (see Table 3.2.). If the participant's capital is not enough, they can get a loan of 15 000, -, which they must pay off each round with 1 000, - and a rent of 500, - per round. Once participants have a loan, they can increase it to 15 000, - twice more during the game.

TABLE 3.2. Financial advantage related to the number of stables

Number of stables	Financial advantage
1 stable	-
2 stables	-
3 stables	3 000
4 stables	4 500
≥ 5 stables	5 000

Each round in the game consists of the following steps: (1) policy, (2) external event, (3) chance card, (4) investment, (5) yearly payment, (6) income, and (7) sector acceptance score (see Figure 3.2.). In step 1, participants are updated by the game facilitator on whether a stricter policy is introduced in the game. A stricter policy requires them to invest in a straw stable within 5 years. In step 2, participants are updated by the game facilitator on expected market price fluctuations as a consequence of a sector incident and on new opportunities for investment in market segmentation: the local market and supermarket segment (as explained above). In step 3, participants can individually or collectively invest in a chance card. The price of a chance card depends on the number of participants in a session, i.e. 500, - units of capital per participant. A chance card gives participants

the opportunity to increase the sector acceptance score. Once a chance card is bought, the information on it shows what must be done to increase acceptance scores. Depending on whether and how often participant(s) buy a chance card, participants get different opportunities. The chance cards comprise: investments in sector promotion to increase the sector acceptance score; subsidy on a straw stable if a minimum of three participants participate (to stimulate further interaction) and subsidies on conversion to other market segments; and an innovation that increases participants' individual acceptance score, which is not related to any market segment, i.e. a pig toilet stable. The pig toilet stable separates different function areas of pigs in the stable, e.g. resting and manuring area, to improve animal welfare, and reduce ammonia emissions and particulate matter. In step 4, each participant can make an investment decision. In step 5, participants that have yearly payments need to pay. In step 6, participants are updated about market prices and receive their income. In step 7, participants are informed by the game facilitator on the sector acceptance score, i.e. the average of the individual acceptance scores.

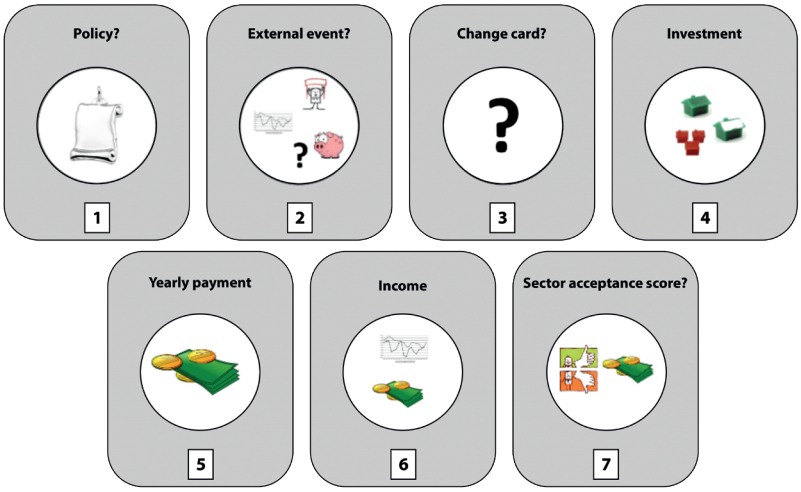

FIGURE 3.2. Steps per game round

3.2.3. GAME PARTICIPANTS

We aimed for experienced and representative groups of participants. Therefore, we sought groups of participants who ideally were pig farmers or affiliated to the sector as advisor or successor. Per session, we also looked for participants who already knew each other, so that they would form a credible reference group. This is also the usual state of affairs in the sector; people know one another. Two groups were found via the following farmer youth organisations, i.e. National Farm Youth Organisation (Nederlands Agrarisch Jongeren Kontakt) and Noord-Brabant Farm Youth Organisation (Brabants Agrarisch Jongeren Kontakt). Five groups were found via the snowball approach in the researchers' network: the first group was found via a pig farmer in the family of the researcher; the second and third group, who were part of the same study group, were found via a bank advisor who participated in the first; the fourth and fifth group, also part of the same study group, were found via a feed advisor who participated in the third group.

A total of seven sessions were played, with 4-8 participants, and with farmers and advisors mainly from the South Eastern region of the Netherlands, which is the region with the highest number of pigs and pig producers in the country. Every session had a combination of pig farmers and/or successors, and advisors. They knew each other via a farmer group or association, i.e. study group, business course or farmer youth organisation (see Table 3.3.). Most of the participants were male, two out of 39 were female. The remainder of the text is, therefore, written in the masculine form.

3.2.4. ANALYSIS OF RESULTS

To analyse the effect of social interaction on diffusion of investment strategies, (1) participants were asked to fill in a form during the game on what investment decisions they had made during each round, (2) all game sessions were video- and voice- recorded, and (3) interaction between participants was transcribed per game session. In the analysis we focused on the investment strategies described in the introduction: the extra stable representing scale enlargement; the intermediate market segments, i.e. intermediate-, local, and supermarket segments; and the niche market segment. The intermediate markets and the niche market represent market differentiation. The 'smaller' investments i.e. course in pig signals, the vista stable, and the straw stable, were left out of the analysis. We organised the analysis in four steps.

TABLE 3.3. Information of participants in each game session (i.e. number, participants' profession, overarching organisation, location of farms

Session	Number of participants	Participants' profession	Organisation through which participants are connected	Location farms
1	8	3 pig farmers, 5 advisors	Business course	Northern Limburg
2	5	4 pig farmers 1 advisor	National farm youth organisation	Noord-Brabant & Overijssel
3	6	3 pig farmers 1 real estate renter 1 advisor 1 manager pig farm	Study group pig farmers	Northern Limburg
4	6	4 pig farmers 1 advisor	Study group pig farmers	Northern Limburg
5	5	1 pig farmer 4 (potential) pig farm successors	Noord-Brabant farm youth organisation	East Noord-Brabant
6	6	2 pig farmers 2 pig farm employees 1 advisor	Study group pig farmers	East Noord-Brabant
7	4	2 pig farmers 1 advisor 1 not provided	Study group pig farmers	East Noord-Brabant

3.2.4.1 DIFFUSION AND RELATION BETWEEN DIFFUSION AND TYPE OF INVESTMENT STRATEGY

First, to gain insight in the differences in diffusion of investment strategies, the percentages of participants who adopted an investment strategy during the game session were compared. Note that participants can adopt multiple investment strategies during the game. A participant can, for example, first adopt an intermediate market segment and then convert to a niche market segment.

Second, to gain insight in the effect of social interaction on diffusion of investment strategies, we first explored other possible causes for differences in diffusion of investment strategies. We did this by looking into the relation between type of investment strategy, i.e. financial and/or societal, and type of diffusion, i.e. no adoption, low adoption, or high adoption. No adoption means no one adopted the investment strategy, low adoption means half or less than half of the participants adopted the investment strategy, and high adoption means that more than half of the participants adopted the investment strategy.

3.2.4.2 DIFFUSION AND SOCIAL INTERACTION: COMMUNICATION AND PROCESSES OF INFLUENCE

Third, we explored the role of individual differences versus group differences regarding their opinion towards each investment strategy, by analysing communication between participants during the session. Each session is played by one group of pork sector stakeholders. A session, therefore, represents one group. Each investment strategy in each session was categorised by the type of communication: no communication, solely arguments in favour of adoption; solely arguments against adoption; or arguments for and against adoption. A session with arguments for and against adoption of an investment strategy, for example, demonstrates individual differences within the session, while solely arguments for adoption in one session demonstrates group cohesion regarding an investment strategy. If in another session, solely arguments against adoption of the same investment strategy are communicated, it is an example of differences between sessions, i.e. group differences. In addition, to gain a deeper insight in differences between individual-, and group perceptions regarding each investment strategy, we investigated the variety of arguments for or against adoption regarding each investment strategy. For each type of argument, it was explored whether it was a commonly used argument in different sessions and for different investment strategies or not.

Finally, to gain insight in the processes of influence as a consequence of social interaction, we first explored the arguments participants used that were a consequence of social interaction, e.g. social learning, or the arguments that participants used to guide other participants decisions, e.g. coordination. Then we tried to gain insight in the effect of opinion leadership on diffusion, by identifying the opinion leader(s) in each session and exploring its influence on adoption of investment strategies among other participants. For both investments, i.e. investment in a chance card to (collectively) reach a higher sector acceptance score and individual farm investments, the potential opinion leader(s) in each session were identified, i.e. the participant with most influence on other participants in the game. We assumed that a session had an opinion leader if three conditions were met: (1) a participant needed to have the highest number of suggestions, i.e. showing leadership behaviour; (2) the same participant needed to have the highest number of implemented suggestions, i.e. evidence of most influence on other participants in the game; and (3) the number of implemented suggestions needed to be at least two higher than the number of implemented suggestions by at least half of the other participants in

the game, i.e. evidence that the person stands out in influence on other participants in the game. If there were two participants with either the highest number of suggestions and/or highest number of implemented suggestions, we looked at the highest number of implemented suggestions, i.e. influence, to decide whether there were one or two opinion leaders. To identify potential opinion leader(s) in cooperation we, therefore, first counted the number of original suggestions for cooperation per participant per session. Second, the number of suggestions for cooperation that were truly implemented by (part of) the group were counted. Third, the participant who met above conditions was identified as the potential opinion leader in that session for cooperation. The potential opinion leader(s) for individual investments were identified by counting the number of original arguments (positive or negative) regarding investments, and by counting the number of times a participant was the first to decide to adopt or not adopt an investment. To analyse the influence of the potential opinion leader on diffusion of investment strategies, we first checked whether the opinion leader in cooperation was the same person as the found opinion leader in farm investments. Second, in case an investment was adopted by more than half of the participants, the process of adoption during that particular session was analysed more in depth by unravelling the communication between the opinion leader and the other participants; i.e. the opinion leader's statements were identified as well as the sequence of farmers who followed his example, i.e. who was the first to decide to adopt and followed etc.

3.3 RESULTS

3.3.1 DIFFUSION AND RELATION BETWEEN DIFFUSION AND TYPE OF INVESTMENT STRATEGY

Across all participants, the extra stable was adopted most (44%), followed by the intermediate segment without subsidy (26%), the local market and intermediate market with subsidy (15%), and finally the supermarket and the niche market (10%) (see Table 3.4.). Sessions varied in the percentage of participants who adopted an investment strategy during the game session (see Table 3.4.). The extra stable, and conversion to the intermediate market with subsidy (see Table 3.4.) differed in diffusion between sessions: in some sessions these investments were adopted by zero or one participant during the

game whereas in other sessions more than half or all the participants adopted them. These investments had in common that they had a (temporary) financial benefit: the extra stable had clear financial benefits (starting from the third stable, see Table 3.2.), the subsidy on the intermediate market segment gave a temporarily relative financial benefit.

TABLE 3.4. Per investment strategy and per session: diffusion (percentage of participants who adopted an investment strategy) and the type of communication regarding an investment strategy, i.e. solely arguments for adoption (+), solely arguments against adoption (-), both arguments for and against adoption (+/-), or no communication regarding the investment strategy ( ).

Session number:		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Number of participants:		**8**	**5**	**6**	**6**	**5**	**5**	**4**	**39**
Extra stable	diffusion	0%	80%	50%	100%	40%	40%	0%	44%
	communication	+	+	+	+/-	+/-			
Intermediate without subsidy	diffusion	0%	40%	17%	33%	20%	40%	50%	26%
	communication	-	+/-		+/-	+/-		+	
Niche	diffusion	0%	20%	0%	0%	20%	20%	25%	10%
	communication		+	-		+	+	+	
Market segments introduced during the game									
Local market concept	diffusion	25%	0%	33%	0%	0%	33%	0%	15%
	communication	+/-	-	+/-	-	+/-	+		
Supermarket concept	diffusion	50%	0%	0%	0%	0%	0%	0%	10%
	communication	+	+/-	-	+/-	-	+/-	-	
Investment subsidy dependent on chance card									
Intermediate with subsidy	Chance card yes/no	yes	no	yes	no	yes	no	yes	
	diffusion	13%		17%		60%		25%	15%
	communication	+/-		+/-		+			

The intermediate market segment without subsidy, and the niche market segment showed only minor differences in the number of participants who adopted between game sessions: in six out of seven sessions one or two participants adopted the intermediate

market, and in four out of seven sessions one participant adopted the niche market. The intermediate market segment was an investment with reversible changes, required a small initial investment and had no financial benefit compared to the conventional market. The niche market was an investment with irreversible changes, required a large initial investment and the financial advantage was partly dependent on adoption by other participants that influenced supply. Lastly, the local market concept was adopted in three out of seven sessions, and the supermarket concept in one out of seven sessions, when they were introduced in the game (see Table 3.4.). Like the intermediate market, they had no financial benefit compared to conventional.

3.3.2 SOCIAL INTERACTION AND DIFFUSION

3.3.2.1 SOCIAL INTERACTION: DIFFUSION AND COMMUNICATION

Overall, sessions differed in whether participants communicated their arguments for or against adoption of an investment strategy and whether this resulted in high, no or low adoption of an investment strategy (see Table 3.5.). In three sessions there was high adoption of an investment strategy. In two of those sessions, only arguments favouring adoption were communicated. In the other session arguments against adoption were also communicated. Sixteen sessions had no adoption of an investment strategy. Only in one of these sessions, solely arguments for adoption were shared. This was in session one where participants did not have the opportunity to invest in an extra stable but would have wanted to. In all other sessions, there was either no communication or arguments against adoption were (also) communicated. Twenty sessions had low adoption of an investment strategy. In none of these sessions, solely negative arguments were communicated.

TABLE 3.5. Number of sessions in which the type of arguments regarding investment strategies (no, for, against, or for & against) resulted in the type of diffusion of investment strategies (high adoption, no adoption, low adoption).

Adoption:	**high**	**no**	**low**	**Total**
No communication		4	4	8
Arguments for adoption	2	1	8	11
Arguments against adoption		6		6
Arguments for and against adoption	1	5	8	14
Total	3	16	20	

The number of arguments for and against adoption of an investment strategy differed. The extra stable saw least variety in arguments for and against adoption across sessions (see Table 3.6.). There were two arguments used for adoption in all sessions, which referred to (i) the financial benefit, e.g. "mass is cash" (sessions 1, 2, 3, 4, and 5); and (ii) make the game more dynamic, e.g. "I'll build a stable, for the game" (session 3). Participants also argued against adoption by referring to risks related to low financial buffers after the investment, e.g. "then our financial buffer will be too small" (sessions 4 and 5). For the niche market, an investment with irreversible changes, the variety in arguments was relatively small too. One argument used against adoption referred to the experience of other farmers in real life, i.e. "I have seen what a miserable situation organic production is, I am not going to start with that" and "straw is also nothing, everyone quit with that" (session 3). Arguments for adoption, on the other hand, were more diverse. One argument regarded again the real life experiences of other farmers: "in niche people earn a lot of money nowadays" (session 7). The other arguments pointed at (i) the financial benefit under the condition that only one or two participants should invest in the niche (sessions 2, 5 and 6), or intermediate market segment (see Table 3.6.); and (ii) the relative benefit when there is a required investment from policy (session 2). All together all arguments underlining the income effect of investments.

TABLE 3.6. An overview of all arguments that are used by participants regarding investment strategy/strategies during the sessions.

STRATEGIC INVESTMENTS - Arguments against adoption							
Argument	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. There is no financial benefit	i; is; l	i; l	s	i; l	i; l; s	s	s
2. Decrease of farm value	l						
3. A relatively expensive investment to increase societal acceptance		s					
4. Others proofed it was a worthless investment			n				
5. I don't like the type of work that comes with the investment			l	s			
6. The financial buffer will be too small after the investment				e	e		
7. I would like to, but I cannot		s				s	
8. Mistrust the subdidy			is				
9. Increase diversity in investment strategies					is	l	
STRATEGIC INVESTMENTS - Arguments for adoption							
Argument	**1**	**2**	**3**	**4**	**5**	**6**	**7**
10. Mass production gives a financial advantage	e	e	e	e	e		
11. The number of producers should be small		i; n	is		i; n	n	
12. There is no need for an extra loan				i			
13. It gives a one-time financial benefit	is		is		is		
14. This will give a higher acceptance score				i	is		i
15. It is a relatively cheap investment for a higher acceptance score		i					
16. It is a flexible investment, opportunities are still open in the future					i; is		i
17. This is what the future will be		i			i	s	
18. It is an interesting investment to avoid policy investments		n					
19. Current producers in the market segment show it is financially beneficial (in reality and in the game)	s						n
20. Interesting investment dependent on investment history	l			s	l	l	
21. Certainty of income	l						
22. Increase diversity in investment strategies	l		e				

e *extra stable* — *n* *niche market segment*
i *intermediate segment without subsidy* — *l* *local market segment*
is *intermediate segment with subsidy* — *s* *supermarket segment*

For the intermediate markets, i.e. investments with reversible changes, one argument against adoption was used in all sessions, i.e. there is no financial benefit for the farmer: "I have seen that it does not pay off", "I don't earn anything with it" or "the investment is lost". For the supermarket segment and the local market segment, additional arguments against adoption were used. These arguments related to specific characteristics of the market (see Table 3.6.), i.e. "it will decrease my farm value if I cannot enlarge" (session 1); a relatively expensive investment for an increase in societal acceptance (session 2); and "I don't want to go to the butcher to sell my meat and stuff" (session 3), which pointed to the personal preferences regarding the type of work that comes with the market segment (sessions 3 and 4). The arguments for adoption of the intermediate market segment differed widely within and between sessions (see Table 3.6.). Apart from the argument that the number of producers should be small (sessions 2, 3, and 5), other arguments used for adoption of the intermediate market related to (i) the low financial risk, e.g. "there is no need for a loan" (session 4); (ii) the increase in acceptance score (sessions 4 and 7); (iii) a relatively cheap investment for a higher acceptance score (session 2); (iv) flexibility of the investment (sessions 5 and 7), e.g. "I still have the option to mass produce later"; and (v) expectations regarding future market developments (sessions 2 and 5). Arguments that were used for adoption of the local and supermarket segment were: (i) that it was proven to be financially beneficial in the game (session 1); (ii) interesting dependent on past investments (sessions 1, 4, 5 and 6), e.g. "interesting for the participants who did not want to invest in previous rounds" (session 5), and "financially interesting for those who already invested in straw" (session 1, 4 and 6); (iii) certainty of income (session 1), e.g. "certainty of income for the next 4 years"; and (iv) to make the game more dynamic, e.g. "there must come diversity", and "otherwise we all do the same" (session 1). The intermediate market with subsidy had one extra argument in favour of adoption, which was the subsidy itself, i.e. "a one-time relative financial benefit" (sessions 1, 3 and 5), and an extra argument against adoption, which also referred to the subsidy, e.g. "there is a catch to this subsidy (…). This could lead to over-supply" (session 3); and to the dynamics in the game, e.g. "I'll do something different than the others" (session 5).

3.3.2.2 SOCIAL INTERACTION: DIFFUSION AND PROCESSES OF INFLUENCE

Processes of influence: coordination & learning

The arguments for and against adoption by participants during the game sessions pointed to processes of influence. Several arguments pointed to coordination among participants through communication: arguments 9 and 22 (see Table 3.6.) coordinated investments to make the game more dynamic by increasing diversity in investments; and participants who used argument 11 (see Table 3.6.) tried to ensure financial benefits by making sure not too many participants entered a market segment. Arguments 4 and 19 (see Table 3.6.) point to learning among participants, i.e. the investment experience of other participants or farmers in real life led participants to argue for or against adoption.

Processes of influence: opinion leadership

The opinion leader in collective investments met the following conditions: (1) the participant had the highest number of suggestions (can be considered as leadership behaviour); (2) the same participant had the highest number of implemented suggestions (can be interpreted as having most influence on other participants in the game); and (3) the number of implemented suggestions were at least two higher than the number of implemented suggestions by at least half of the other participants in the game (can be considered as the person stands out in influence compared to others). In all sessions except session 3, one (session 1, 2, 5, 6, 7) or two (session 4) opinion leaders regarding cooperative investments for a higher sector acceptance were identified (see Table 3.7. italic and bold numbers). The opinion leaders got support from all other participants from the start (session 4, 7), had to convince one disagreeing participant to contribute (session 1, 5, 6), or encountered only one or two participants who did not support the initiative for cooperative investments at all times (session 2). In some sessions, the opinion leader's initiative was followed at almost all times (sessions 6, 7), in other sessions not (session 1, 2, 4, 5).

TABLE 3.7. Number of suggestions (i.e. #SUG) and implemented suggestions (i.e. #IMP) regarding cooperation for higher Sector Acceptance per participant per session.

Session:	**1**		**2**		**3**		**4**		**5**		**6**		**7**	
Participant	**#SUG**	**#IMP**	**#SUG**	**#IMP**	**#SUG**	**#IMP**	**#SUG**	**#IMP**	**#SUG**	**#IMP**	**#SUG**	**#IMP**	**#SUG**	**#IMP**
1	**10**	**4**	0	0	1	2	**9**	**3**	7	1	2	2	2	0
2	0	0	4	1	1	1	1	0	**19**	**5**	1	0	7	7
3	1	1	0	0	2	0	1	1	8	1	1	0	4	3
4	1	1	2	1	7	3	6	1	17	1	0	0	0	0
5	0	0	**7**	**4**	6	2	**7**	**3**	16	2	**4**	**3**		
6	1	0			7	2	7	2						
7	1	1												
8	2	1												

The opinion leaders in collective investments adopted an extra stable (session 1, 2, 4) and/or the intermediate market segment (session 2, 6, 7). One opinion leader adopted the niche market (session 5). Their investment decisions did not correspond with the decisions of all other participants in the game sessions. The opinion leader in individual investment strategies was identified by 1) the largest number of arguments expressed for or against adoption of an investment strategy and 2) the largest number of times the participant was the first to decide to adopt an investment strategy (see Table 3.8. italic and bold numbers). In session 1, participant 1 was the identified opinion leader in collective investments, while participant 4 was the participant who expressed most arguments for or against adoption of investment strategies and in being the first to decide whether to adopt. In all other sessions the identified opinion leader(s) in collective investments was also the participant who expressed most arguments for or against adoption and the participant who most often was the first to decide whether to adopt an investment strategy.

TABLE 3.8. Number of assessments regarding individual farm investments communicated (i.e. #ASC) and first decisions made (i.e. #DEC) per participant per session

Session:	**1**		**2**		**3**		**4**		**5**		**6**		**7**	
Participant	**# ASC**	**# DEC**	**# ASC**	**# DEC**	**# ASC**	**# DEC**	**# ASC**	**# DEC**	**# ASC**	**# DEC**	**# ASC**	**# DEC**	**# ASC**	**# DEC**
1	2	4	1	1	3	1	**8**	3	0	2	1	1	1	0
2	1	1	2	4	2	3	2	0	**6**	3	1	1	**3**	**5**
3	1	2	6	3	0	1	0	1	1	1	0	2	1	2
4	**4**	**6**	2	2	2	1	3	1	3	3	0	2	1	1
5	2	2	**10**	**5**	**4**	3	3	**6**	3	3	2	2		
6	3	2			2	1	2	2						
7	0	0												
8	0	0												

In session 4 and 5, the arguments for and against adoption of respectively the extra stable and the intermediate market segment with subsidy of the opinion leader did seem to influence high adoption of the extra stable (session 4) and the intermediate segment with subsidy (session 5). In session 4, one of the opinion leaders framed the investment in an extra stable as risky in that particular round. Three participants who planned to invest in an extra stable did, consequently, not invest in an extra stable in that round. In the next round, the other opinion leader did invest in an extra stable, and four participants followed. In session 5, the opinion leader framed investments that were provided with a subsidy as relatively cheap, and, consequently, the intermediate was adopted by three participants who were (still) conventional. In session 2 where the extra stable became popular, the arguments for adoption were not expressed by the opinion leader, but the opinion leader was the first to decide to adopt.

3.4 DISCUSSION

3.4.1 OUTCOMES GAME SESSIONS

In this research, we used an experimental game setting to explore effects of social interaction on diffusion of the following proposed investment strategies by policymakers and researchers within the Dutch pork sector: 1) scale enlargement and modernisation; 2) convert to an intermediate market segment, and 3) convert to a niche market segment. The game was designed to free participants from contextual constraints that limit farmers' options in real life. We did this by equalising farm resources and external changes, and by giving participants an initial chance of choosing between all available strategic investment options at the start of the game. The discussion is organised as follows: first we discuss our results in relation to the research questions and literature. Then we evaluate the method and give directions for future research.

3.4.1.1 RESULTS

The sessions showed a relatively equal diffusion of the intermediate market segment without subsidy and the niche market segment. Adoption of the two introduced intermediate market segments, i.e. the local and supermarket segment, differed between sessions: either no one adopted, or the minimum number of participants adopted. The extra stable and the intermediate segment with subsidy were the only two investment strategies that differed between sessions: it resulted in high adoption in some game sessions, while no adoption occurred in other sessions. The latter two investment strategies were also the only two investment strategies with a clear (relative) financial benefit.

Communication was related to diffusion: sessions with high adoption of an investment strategy were characterised by positive communication, while sessions with no adoption of an investment strategy were characterised by no or negative communication. Differences between individuals in opinion regarding intermediate market segments and coordination among participants to ensure financial benefits inhibited diffusion of this strategy. This strategy saw the most diverse arguments in favour of and against adoption. On the other hand, individuals differed least within and across sessions in opinion regarding the extra stable and the niche market segment, i.e. there was a common understanding among participants across sessions of the positive and negative aspects of these strategies. Under influence of opinion leadership this positively affected diffusion of the extra stable, but

under influence of coordination to ensure financial benefits this inhibited diffusion of the niche market segment. In addition coordination inhibited diffusion of all investment strategies through arguments to enhance learning among participants by increasing diversity of investment strategies in the game. Finally processes of social learning contributed both to and against diffusion of the same investment strategy.

3.4.1.2 RESULTS IN RELATION TO EXISTING LITERATURE

The possibility for high adoption of the extra stable found in our study is in line with the investment strategy by the majority of pig farmers in reality who have focused on production efficiency and scale enlargement (CBS, 2017; Hendrickson & Miele, 2009). The percentage of participants who adopted an intermediate market segment without the certainty of price premiums in our study, i.e. 66% (intermediate, local and supermarket segment), however, is lower than the percentage found by Gocsik et al.(2015), i.e. 77% of pig farmers in their study were willing to convert to an intermediate market segment with reversible changes given the same expected income. On the other hand, the percentage does confirm the high willingness among participants to invest in higher requirements for animal welfare. The same expected income, however, was not enough for high diffusion to occur, as opposed to the certainty of a financial benefit. The importance of a financial benefit is consistent with the empirical findings of Ambrosius et al., (2015) and Gocsik et al., (2015), who found that the certainty of price premiums is an important factor in strategic investment decisions of intensive livestock farmers. Adoption research also highlights the importance of an increase in economic viability of the farm in favour of diffusion (Lindner, 1986; Rogers, 2003).

The variety between pig farmers in their opinion regarding investment strategies is known (de Rooij, de Lauwere, & van der Ploeg, 2010; Gocsik et al., 2015), as well as the arguments used by participants, i.e. the importance of risk, lock-in due to past investments (Ambrosius et al., 2015), importance of a financial benefit (Gocsik et al., 2015), importance of a flexible investment (Gocsik et al., 2015), and societal orientation (de Rooij et al., 2010). The low diversity in arguments against adoption of an extra stable, however, is not in line with results from other studies. Researchers, for example, argue that the competitiveness of Dutch pig production in the world market diminishes, and that for many farmers it is, therefore, of interest to look at added-value markets (Backus & Dijkhuizen, 2002). Also, some individual farmers recognise the need to respond to

societal criticism (de Rooij et al., 2010), which includes the critique towards large-scale farms.

Finally, the processes of influence that led to diffusion, i.e. communication between participants and opinion leadership, are known mechanisms in diffusion research (Feder & Umali, 1993; Rogers, 2003; Sultan, Farley, & Lehmann, 1990; Valente & Davis, 2013). The process of influence that inhibited diffusion, i.e. coordination among participants, is a known mechanism in the Dutch organic pork meat market, but demand is not known by individual farmers (Ambrosius et al., 2015). Coordination to enhance learning was a game induced motivation, to increase game dynamics. This confirms that the gaming environment functioned as a safe environment to enhance learning (Hofstede et al., 2010).

3.4.1.3 LESSONS LEARNED

In this study high adoption was characterised by a combination of factors: (1) an investment strategy that had a clear (relative) financial benefit, (2) positive communication between participants regarding the investment strategy, and (3) the identified opinion leader played an essential role in diffusion of an investment strategy, either as being the first to decide to adopt or through arguments. Social interaction as such, therefore, is not sufficient to explain diffusion. On the other hand, without an analysis on the role of opinion leadership, diffusion could have been interpreted as a result of farmer's rational decision-making due to the financial benefit of the investment strategy. The role of social interaction should, therefore, not be underestimated at the same time. Furthermore, an analysis of commonly held arguments versus diverse arguments across sessions showed that social learning over time, e.g. through investment experiences of farmers in real life, resulted in a common understanding regarding the benefits versus disadvantages of investment strategies that have been around for a relatively long time, i.e. scale enlargement and the niche market. More recent investment strategies, i.e. the intermediate markets, were met with diverse arguments on theoretical benefits versus financial risks. Most of these arguments were used in less than half of the sessions. This means that within sessions 'local' realities regarding this investment strategies existed. The study, therefore, showed that social learning seems to be an important mechanism in the development of a common understanding or frame of reference amongst this group of participants.

3.4.1.4 LIMITATIONS & DIRECTIONS FOR FUTURE RESEARCH

The difference between the participants in our study and people outside the pork sector and individual farmers, suggests there was a common understanding among participants in our sessions in favour of growth-oriented farming, and that reasons against adoption of an extra stable were not widely supported or known. Another explanation could be that the norm was in favour of growth-oriented farming, and that participants did not want or dare to share arguments against adoption of an extra stable. The latter was found in previous research, where farmers who move away from conventional growth oriented production are criticised by other farmers (Ambrosius et al., 2015). In addition, this study showed that social interaction through coordination inhibited diffusion of investment strategies due to strategic management of financial benefits. On a larger scale, i.e. with more participants, the success of coordination is likely to diminish, and this effect is likely to fade. Finally, the effect of social learning might have been easier to observe if more rounds per game were played. The relative low number of rounds, i.e. 10, limited the ability to learn about its effect in the long run. A 'quicker' game design that allows for more rounds is better able to capture this effect.

3.4.2 EVALUATION OF METHOD

The simulation game encouraged participants to share arguments for and against adoption of investment strategies that have proven to be important factors in real-life investment decisions in previous research. This supports the finding that one of the strengths of more realistic game designs is that they can trigger tacit knowledge of participants (Anderies et al., 2011; Vieira Pak & Castillo Brieva, 2010). To gain knowledge about farmer-specific behaviour, it is important to select participants that are familiar with the case presented, because they can 'fill in the blanks', i.e. they reflect on criteria that are not represented in the game, such as experience of other farmers in real life and labour conditions associated with a certain investment. Participants were especially triggered to publicly reflect on investment strategies when investments were introduced during the game and which required immediate reaction. Interaction during the game could easily be observed with a camera, and results pointed to mechanisms of interest and the possible diversity in outcomes as a consequence of different social settings. In addition, the possible consequences of social interaction and previous decision-making is nicely captured, because it allows to simulate multiple rounds that capture the consequences of previous

decision-making and social interaction. The choice for groups of participants that already knew each other is likely to have influenced decisions in the game through existing norms on good investment strategies and management of sector acceptance. Finally, the steps undertaken to analyse whether diffusion was caused by social interaction and/or investment characteristics or individual differences proofed to be important.

3.4.2.1 LIMITATIONS OF THE GAMING METHOD & DIRECTIONS FOR FUTURE RESEARCH

The gaming methodology invited participants to try and 'win' the game. Their interpretation of game goals, i.e. a high individual or common acceptance score and/or most capital at the end of the game, influenced their decisions especially at the end of the game. Farmers in reality, on the other hand, deal with similar questions in terms of good farming practices (de Rooij et al., 2010). The methodology, furthermore, invited participants to experiment and learn, inhibiting diffusion of a single investment strategy. In addition, the game was represented as a board game and played with a maximum of eight people. Consequently, participants had full information on the behaviour of others, which, among others, enabled coordination for higher prices. This inhibits diffusion of an investment strategy as well, and coordination among large numbers of farmers in reality would be difficult. To overcome the limitations of a small group, social interaction effects on diffusion between larger groups of farmers can be studied with the help of computer simulations.

In addition, the use of a game caused a bias in selection of participants. Farmers and farmer representatives who declined the invitation to participate in this research argued it was something radically different from the meetings they normally have, that it would not be taken seriously by their farmers, or that the topic of the game, i.e. innovation and sector acceptance, was a sensitive subject in their area. Furthermore, especially young farmers or successors were willing to play the game. Farmers who did participate were, therefore, more likely to produce in an area with less tensions, be more open for new experiences, or relatively young and willing to play games. In addition, the difficulty in finding participants led to a mixed group of participants, i.e. pig farmers, sons of pig farmers and pork sector stakeholders. This could have influenced game results through unequal status for example, or a higher willingness to experiment. On the other hand, the pork sector stakeholders in our sessions were part of existing groups, i.e. study groups of

farmers or a business course. They, furthermore, visit the farmer regularly and are arguably an important actor in decision-making. The fact that they were also represented in the game sessions is, therefore, not very different from reality. The invitation for the game evening that was send to pig farmers in the last two sessions did not mention the game as such and confirmed that the methodology affected participant selection: one farmer left after he heard it was a game evening and one participant did not trust the intentions of the researcher and the use of a camera. Video recordings in other sessions did not seem to affect the participants behaviour, especially once they got 'into' the game after the trial rounds. Finally, extra sessions with different groups of farmers, i.e. organic farmers, might result in high adoption of other investment strategies than scale enlargement or the intermediate market with subsidy. In these groups coordination could, however, also inhibit diffusion of investment strategies. Extra sessions could also back up trends that came out in current sessions.

3.4.2.2 LIMITATIONS OF METHODS TO ANALYSE DATA

The conditions used to identify opinion leaders were used to select the most influential participant. These participants did not have to be influential on all others in the session, e.g. a part of the group would have been enough to cooperate for a chance card. In addition, the identified opinion leader could have been influential at the start of the game only while loosing his influence at the end of the game, or the other way around. It would be interesting to develop methods to track the development of influential participants and the behaviour of its followers. Finally, we would like to mention that the methodology used in this study is time consuming, through development of the game, selection of participants and transcription of the game sessions.

3.5 CONCLUSION

This study explored the effect of social interaction on diffusion of investment strategies in groups of pork sector stakeholders using a simulation game. The results show that (1) only investment strategies with a financial benefit did, under influence of social interaction, result in high adoption; (2) for high adoption to occur communication between participants was necessary; (3) opinion leaders played an essential role in high

adoption of investment strategies; and (4) there was a common understanding among participants that favoured scale enlargement. The gaming methodology influenced the selection of participants, invited participants to experiment and coordinate investment strategies among themselves, and triggered participants to communicate their tacit knowledge. The results could be used for further exploration in computer simulations to explore the effect of social interaction between many farmers on diffusion of investment strategies.

ACKNOWLEDGEMENTS

The authors thank David Crookall for ideas and advice on game design, Robert Hoste and Carola van der Peet-Schwering for their knowledge and comments for improving the representation of the pork sector in the design of the game. Robert Hoste for his knowledge about market fluctuations and costs of new housing systems. Carola for her knowledge on innovations in pig housing systems. We would further like to thank Geert van der Peet, Jos Peerlings, and Robert Stienen in helping to find interested study groups of pig farmers. In particular we would like to thank all pig farmers and pig farmer advisors for their time, interest and openness to try-out new methods, to play the game and discuss their experience, knowledge, and decision-making regarding housing systems and market differentiation. We would furthermore like to thank all students, post-docs, and PhD-students for their willingness to play the game to test it for its simplicity and playability and for their suggestions to improve both. Finally, we would like to thank Francine Pacilly, Iris Boumans, Roos Adelhart-Toorop, Marion Schoenmakers, Eline de Jong, Giulia Salvini, and Elco Mijdam for their assistance during the game sessions. This work was supported by the 'IP/OP' investment programme 'Complex Adaptive Systems' of Wageningen UR, the Netherlands.

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APPENDIX 3.A. GAME DESIGN DECISIONS AS A RESULT OF PILOT SESSIONS

3.A.1 PILOT SESSIONS WITH STUDENTS

The tests with students and sons of pig farmers resulted in some small modifications: prices connected to a stable, instead of the number of pigs within a housing system, more investment options for participants to increase individual acceptance scores, i.e. a vista stable (a stable designed to welcome visitors), a straw stable (a stable that provides for exploring needs of pigs) and a course to learn more about pig behaviour, i.e. a course in pig signals.

3.A.2 PILOT SESSION WITH FARMERS AND ADVISORS

Based on the first session with farmers a few extra changes were made: (1) more control for the game facilitator through a predetermination of market price fluctuations of the market segments, instead of price determination in the game with a dice (2) a larger price for the chance card to encourage social interaction through cooperation (i.e. 500,- units of capital per participant instead of 1000,- in total), and (3) a more realistic representation of market price fluctuations for the local market and supermarket concept through price fluctuations that equal the intermediate market (i.e. prices connected to conventional with a compensation in cost price) instead of niche (i.e. high fluctuations in prices).


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CHAPTER 4

UNDERSTANDING DIFFUSION OF ORGANIC FARMING AMONG DUTCH PIG FARMERS: AN AGENT-BASED MODEL

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Submitted to Agricultural Systems

ABSTRACT

Organic farming is an alternative for conventional farming practices with the potential to decrease negative externalities of intensive farming methods. Yet, in the Netherlands there has often been a mismatch between societal preferences towards alternative farming strategies like organic on the one hand, and observed farmer behaviour on the other. For example, subsidies on organic farming have resulted in over-supply of organic products and organic farmers have experienced peer pressure to remain conventional. The aim of this research is to gain insight in the factors that contribute to the diffusion of alternative farming strategies, by taking into account social interaction mechanisms, market price dynamics, and heterogeneity in farming styles. A regional cluster in the Dutch pork sector is used as a case study, and the following research questions are answered by means of agent-based modelling: "Which factors are most influential on the number of organic farmers and the number of organic pigs?"; and "Which factors are most influential on the diversity of farming styles in the organic pork sector?". First, we performed an exploratory analysis on the effect of social influence parameters on model results. Then we selected three social influence scenarios for a local sensitivity analysis. We performed expert validation on model results. The exploratory analysis showed that an increase in the likelihood for influence in interaction increases the size of the organic market and increases the diversity of organic farmers' farming styles. In addition, when farmers' dominant reference groups encompasses all other farmers irrelevant of farming style, there is more diversity in organic farmers' farming style. The sensitivity analysis showed that the most influential factor on diffusion of organic farming is the price elasticity of demand for organic pork meat in interaction with the likelihood for social influence between farmers. This is followed by the importance of new entrants. New entrants stimulate organic farming through a different farming style than their predecessor and through different peers. Expert validation showed that in a regulated market, organic pork meat demand, given a static consumer price, limits the diffusion of organic farming, while waiting lists regulate supply. Differences

in supply and demand affect profitability of organic farming among supply chain actors including farmers. Policy-makers aiming to increase the number of organic farmers should focus on financial or communicative policy instruments that target consumer demand and/or young new entrants in the farmer population.

Keywords: social identity approach; social interaction; price elasticity of demand; farmer behaviour; innovation diffusion

4.1 INTRODUCTION

Intensive farming practices produce cheap food, but is also criticised for the impaired animal welfare, and its contribution to climate change, biodiversity loss, poor air quality, soil degradation, stench and the risk of zoonoses (Bergstra, 2013; Coenraadts & Cornelissen, 2011; Hendrickson & Miele, 2009; Maassen, Smit, Wouters, van Duijkeren, & et al., 2017; Natuur & Milieu, 2017; Stichting Varkens in Nood, 2015). Policy makers and citizens call for alternative, demand-oriented, and less intensive farming strategies, with a higher income for farmers, that decrease the negative externalities of production (Jansen, Douma, Hoogeveen, Huirne, & Rosenthal, 2016; Provincie Noord-Brabant, 2017). Yet, there has often been a mismatch between, on the one hand, societal and political preferences towards alternative farming strategies[1] like organic, and on the other hand, observed farmer behaviour. In the past, policies had unintended consequences. In the Dutch pork sector for example, a Dutch governmental subsidy for pig farmers to convert to the organic market around the year 2000 resulted in a higher increase in organic supply than the anticipated increase in demand for organic pork meat. Excess supply resulted in dropped farm gate prices, pressure on organic farmers' income, and a damaged reputation of organic farming as a good alternative to conventional amongst conventional pig farmers (Biologica, 2003). In addition, while organic farming is generally seen by citizens and policy-makers as a viable alternative to conventional farming, farmers feel peer pressure to remain conventional or to defend their choice for alternative farming strategies like organic towards their peers (Alexopoulos, Koutsouris, & Tzouramani, 2010; Ambrosius, Hofstede, Bock, Bokkers, & Beulens, 2015; Lamine & Bellon, 2009). This shows a friction between societal preferences and farmer dynamics. In order to design an effective support strategy for alternative farming strategies, better understanding of the diffusion of alternative farming strategies is needed, in particular effects of market price dynamics and social interaction among farmers.

[1] Organic farming is seen as one of the alternatives to conventional farming practices. In the Dutch pork sector, several alternative markets exists. Alternative markets require alternative farming strategies that decrease negative externalities. The best known and biggest alternative market is the one-star intermediate market, which requires farmers to, e.g. have more space per pig than in the conventional market. Others examples include Krull, Livar, and Hamletz. These farming practices differ in the level of animal welfare and/or environmental pressure. In the remainder of the article, when we mention alternative farming practices, we refer to these alternative farming practices, including organic farming.

4.1.1 FARMER CHARACTERISTICS

Previous research on adoption by farmers of alternative farming strategies or welfare investments focused mainly on farmers' individual considerations, farm and farmer characteristics and/or influence of institutional environment such as policies (Bartkowski and Bartke, 2018; Gocsik et al., 2015; Kemp et al., 2014; Rose et al., 2018; Tuyttens et al., 2008). For example, research has focused on the role of farmers' demographics, such as age (Kemp et al., 2014; Oude Lansink, van den Berg, & Huirne, 2003; Tuyttens et al., 2008) and education (Aubert, Schroeder, & Grimaudo, 2012); farmers' personality, such as their innovativeness (Aubert et al., 2012; Rogers, 2003; Tepic, Trienekens, Hoste, & Omta, 2012) and their openness to experience (Austin, Deary, & Willock, 2001); and on behavioural characteristics, such as beliefs (Palis, Flor, Warburton, & Hossain, 2006; Sok, Hogeveen, Elbers, & Oude Lansink, 2015), attitudes (de Lauwere, van Asseldonk, van 't Riet, de Hoop, & ten Pierick, 2012; Hyland, Heanue, McKillop, & Micha, 2018; Kemp et al., 2014; Willock et al., 1999), and motivations (Mills, Gaskell, Ingram, & Chaplin, 2018; van Duinen, Filatova, Geurts, & van der Veen, 2015; Wilson & Hart, 2000). These studies were done at one point in time and did not take into account interactions between farmers and between farmers and markets.

4.1.2 SOCIAL INTERACTION

Previous research indicates that social influence plays a role in farmer decision-making in general (Bartkowski & Bartke, 2018; Edwards-Jones, 2006; D. C. Rose et al., 2018), and in organic conversion in particular (Alexopoulos et al., 2010; Ambrosius et al., 2015; Lamine & Bellon, 2009). More specifically, social influence is related to specific reference groups (Ambrosius et al., 2015; Burton, 2004), i.e. a real or perceived group whose opinion and behaviour matters to one's choices (Brown, 2000; Kemper, 2011). Important reference groups amongst farmers can be identified via existing farmers' self-concepts, i.e. their definition of being a 'good' farmer and its related 'good' farming practices (Ambrosius et al., 2015; Burton & Wilson, 2006; Commandeur, 2006; de Rooij, de Lauwere, & van der Ploeg, 2010). The differences between reference groups is also reflected by the identification of a variety of farming styles in previous research (Commandeur, 2006; de Rooij et al., 2010; van der Ploeg, 1994; Vanclay, Howden, Mesiti, & Glyde, 2006). Farmers with the same farming style act as reference groups to other farmers, setting implicit norms for practice.

4.1.3 MARKET PRICE DYNAMICS

Apart from social influence, the size of the market of an alternative farming strategy limits adoption (Ambrosius et al., 2015; Ambrosius, Hofstede, Bokkers, Bock, & Beulens, 2019). Markets of alternative farming strategies like organic are small as opposed to international conventional markets where prices are internationally determined. In these small markets any marginal change in supply or demand could potentially affect the farm gate price and therewith farm income (Ambrosius et al., 2019). Both aspects - social influence and market price dynamics - thus need to be taken into account when studying the diffusion of alternative farming strategies.

4.1.4 AIM OF RESEARCH

The aim of this research is to gain insight in factors that contribute to the diffusion of alternative farming strategies. We explicitly consider social interaction mechanisms, market price dynamics, and farming style heterogeneity. More specifically we look at: (1) what factors influence the size of the alternative market?, and (2) what factors influence the diversity of farming styles in the alternative market? Conversion to organic farming in the Dutch pork sector is taken as a case study for the diffusion of alternative farming strategies. In this article the research questions are answered by means of an agent-based model on organic market conversion. Sensitivity analysis and expert validation are performed on model results.

The paper is structured as follows. First, the conceptual framework of pig farmer decision-making and social influence is explained. This is followed by describing agent-based modelling as a method for research and a short literature review on agent-based models of organic market conversion. Then the methods are outlined, including a description of the case study, the model, sensitivity analysis, and expert validation. This is followed by results, discussion and conclusion.

4.2 CONCEPTUAL FRAMEWORK

4.2.1 PIG FARMER DECISION-MAKING BEHAVIOUR

Pig farmer decision-making is related to many factors, which can roughly be grouped into personal, contextual, and social factors (Ambrosius et al., 2015). Personal factors

that are associated with a higher chance to invest in stables are younger age and having a successor (Kemp et al., 2014; Oude Lansink et al., 2003; Tuyttens et al., 2008), a positive attitude towards the alternative (de Lauwere et al., 2012; Kemp et al., 2014), higher innovativeness (Tepic et al., 2012), and an idealistic farming style (Commandeur, 2006; de Rooij et al., 2010). Some of these factors are relatively static, i.e. a pig farmer's innovativeness (Ambrosius et al., 2015) and a farmer's farming style (Burton, Kuczera, & Schwarz, 2008), while other factors are dynamic, i.e. age and attitudes (Helitzer, Hathorn, Benally, & Ortega, 2014).

Contextual factors that influence pig farmers' decision-making are the farmers' investment rhythm and farm size. Farmers' investment rhythm is determined by the useful life of an asset, such as the time that it takes for a stable to be depreciated, and the farmer's opportunity rhythm to make a long-term change on his farm. Whether farmers consider an investment is also influenced by the availability of a successor (Oude Lansink et al., 2003). The farm size is taken into account when considering conversion to organic farming: farmers with a large farm do not see organic as a viable alternative as their additional supply could significantly affect the elastic organic market price (Ambrosius et al., 2015).

Finally, social factors that influence investment decisions are norms and the status of farmers within reference groups. In a game environment, social interactions have shown to influence farmers' strategic investments through opinion leadership (Ambrosius, Hofstede, Bokkers, Bock, & Beulens, 2019). Also, in a study on the adoption of an alternative housing system for sows, i.e. group housing instead of individual crates, those farmers who did not yet convert felt less peer pressure from, e.g., other farmers (de Lauwere et al., 2012).

4.2.2 THE SOCIAL IDENTITY APPROACH

The Social Identity Approach relates social interaction to behaviour change, through the social dimension of a person's self-concept. The main idea behind the Social Identity Approach is that humans have a universal drive to evaluate their opinions and attitudes to increase their self-esteem and/or confidence and status as a group member (Brown, 2000; Hogg, Terry, & White, 1995; Turner & Oakes, 1986). Individuals within a group are motivated to act according to the norms associated with being a member of the group (Brown, 2000), and disagreement in opinion or attitude between in-group members can

result in attempts to reduce the disagreement through social influence (Bagozzi & Lee, 2002; Brown, 2000; Turner & Oakes, 1986). The Social Identity Approach states that the level of influence is based on (1) similarity between self and other(s), i.e. whether they are in-group or out-group members; (2) the similarity of the situational context between self and other(s); and (3) the status of oneself and the other(s) within the group, i.e. the direction of influence, and (4) the level of identification with the in-group (Brown, 2000; Terry & Hogg, 1996; Turner & Oakes, 1986). To understand and model influence between farmers, it is, therefore, important to know about similarity in person, situational context, and what gives status within a certain reference group.

To identify Dutch pig farmers' reference groups we looked at previous findings. First of all, pig farmers take into account their farm size when considering conversion to an added-value market (Ambrosius et al., 2015). Therefore, similarity in farm size matters. Second, organic and conventional farmers opposed each others' practices in the past (de Rooij et al., 2010). Therefore, similarity in market matters. Finally, we looked at previous research on farming styles in the Dutch pig farmer population. Previous research identified three different farming styles that have been relatively stable over time in the Dutch pig farmer population: idealists, craftsmen and entrepreneurs (Commandeur, 2006; de Rooij et al., 2010). They differ in their definition of 'being a good farmer' and in status symbols (see Table 4.1.). Idealists see pig farming as a way to earn a living instead of a way to maximise profits, and they like to keep investments low (Commandeur, 2006). In addition, they value farming methods that incorporate the intrinsic needs of animals in farm design and management. They oppose conventional farming methods that are harmful to animal welfare and think that behaviour of conventional farmers contribute to current societal criticism regarding the Dutch pig sector (de Rooij et al., 2010). Both craftsmen and entrepreneurs opt for maximising profits instead of maintaining a livelihood (Commandeur, 2006). Craftsmen gain profits through high productivity, e.g. intensification through increasing litter size and/or daily growth, while entrepreneurs optimise farm management, scale enlargement and market integration (Commandeur, 2006; de Rooij et al., 2010). Therefore, similarity in farming styles matters, i.e. farmers with a similar farming style are "in-groups", and other farming styles can be regarded as "out-groups". Pig farmers are thus heterogeneous in personality, context, and social factors, and are influenced by their contextual and farming style reference groups through social interaction. In the remainder of this article, we use the term reference group in a social interaction context and farming style in an individual farmer context.

TABLE 4.1. Reference groups in the Dutch pig farmer population, their status symbols according to literature and the status symbols in the model.

Reference group	Status symbols literature	Status symbol(s) in model
Idealists	The level of intrinsic needs of animal on the farm; low investments; farming as a lifestyle	Producing for the organic market (which represents performance on animal's intrinsic needs)
Craftsmen	Profit/income through high productivity	Productivity performance
Entrepreneurs	Profit/income through optimising farm management; farm size; market integration	Income performance Farm size performance

4.3 AGENT-BASED MODELLING

Agent-based models can capture heterogeneous individuals, i.e. agents, and interaction between these individuals, so that it can generate and explore macro-level or group-level outcomes (Flache et al., 2017; Gilbert, 2008; Squazzoni, Jager, & Edmonds, 2014). These include innovation diffusion patterns (Berger, 2001; Deffuant et al., 2002; Kaufmann, Stagl, & Franks, 2009), segregation (Schelling, 1971), and opinion dynamics (Gargiulo & Gandica, 2017; Hegselmann & Krause, 2002). The method is, therefore, a good choice for studying factors that contribute to organic farming diffusion while taking into account pig farmer heterogeneity, social influence mechanisms, and market price dynamics. Since agent-based models are dynamic, they require an understanding of the underlying mechanisms. In this case this means understanding cognitive mechanisms of behaviour change, e.g. how social influence affects farmer decision-making behaviour, as opposed to snap-shot studies on farmer decision-making behaviour. The emergent outcomes of the system, here the diffusion of farming strategies, can in turn be compared with empirics or with expert knowledge.

Previous studies that used agent-based modelling for studying the diffusion of organic farming also included social interaction mechanisms (Deffuant et al., 2002; Kaufmann et al., 2009; Olabisi, Wang, & Ligmann-Zielinska, 2015; Rozman, Škraba, Pažek, & Kofjač, 2017; Xu, Huet, Poix, Boisdon, & Deffuant, 2018). Some studies modelled the effect of social interaction with a social diffusion mechanism (Olabisi et al., 2015; Rozman et al., 2017), e.g. if 50% of the neighbours of a conventional farmer converted to organic farming, the conventional farmer would do so as well. Other studies modelled social interaction

with an opinion mechanism: e.g. if opinions are not too different, farmers influence each other (Deffuant et al., 2002; Kaufmann et al., 2009). Both types of organic conversion models do not take into account the social dimension of interaction, namely the farmers' reference groups that dictates what makes a good farmer, while this has proven to play a role (Alexopoulos et al., 2010; Ambrosius et al., 2015; Home, Indermuehle, Tschanz, Ries, & Stolze, 2018). There is one notable exception to these conversion models, which is the model developed by Xu et al. (2018) on understanding why farmers do not convert to organic. They acknowledge that farmers differ in their views on what makes a good farmer, e.g. environmental or productivity performance (Xu et al., 2018). The social influence mechanism in this model differs from the one in Xu et al. (2018) in two ways. Firstly, the farmers' reference groups in this model go beyond the farmers' current practice: conventional farmers can value environmental performance more than productivity performance or organic farmers can value productivity performance more. This is done, because literature shows that a farmer's idea of good farming practices is based on the current practice and on their ambition (Commandeur, 2006; van der Ploeg, 1994). In other words, organic farmers can have the ambition to increase productivity performance (instead of environmental performance) and conventional farmers can have the ambition to increase environmental performance (instead of productivity performance). Secondly, another farmer's credibility is dependent on similarity in farm context (e.g. farm size) in addition to similarity in farming style. In the model by Xu et al. (2018) similarity is based on environmental and economic performance comparison. In this model we take into account additional reference groups based on similarity, i.e. farming style, farm size and market, next to differences in status according to one's farming style reference group.

Furthermore, in this model market price dynamics of the conventional market and the organic market are modelled. To our knowledge, no previous agent-based model on organic market conversion assumed that additional organic supply would affect organic market prices. This is not realistic in the context of existing evidence that the farm gate price for organic produce is sensitive to new entrants (Ambrosius et al., 2019; Biologica, 2003). Previous models assumed that the organic market price is either fixed (Deffuant et al., 2002), similar to conventional (Olabisi et al., 2015), not taken into account (Xu et al., 2018), or indirectly modelled as a control belief of conversion, where an increase in control belief represents a subsidy or an increase in demand and/or farm gate price (Kaufmann et al., 2009). In this model we include a more sophisticated mechanism to capture market price dynamics.

4.4 METHODS

4.4.1 CASE STUDY DESCRIPTION

The province of Noord-Brabant is the densest pig production region in the Netherlands. The majority of these pig farmers have intensive pig husbandry systems that are characterised by large numbers of animals, specialisation, high capital intensity, and indoor production systems (Geels, 2009; Hendrickson & Miele, 2009). Their income fluctuates due to volatile feed and meat prices (Bondt, Hoste, Boone, & Wisman, 2005; Hoste, Bondt, & Ingenbeek, 2004), while pig production methods are criticised by citizens and consumers (Backus & Dijkhuizen, 2002; de Rooij et al., 2010; Greef & Casabianca, 2009). To increase sustainability in the pork sector, organic farming is proposed as one of four strategic investment options to pig farmers (Provincie Noord-Brabant, 2017). Organic farming gets the maximum evaluation on animal welfare, i.e. three stars, according to the Better Life label of the Dutch animal protection society, whereas conventional farming receive one star or none. Conversion to the organic market requires a change in building and inventory, because of e.g. a higher percentage in solid floors compared to slatted floors, more space per animal, and outdoor access. Conversion to organic is, therefore, considered a strategic long-term and irreversible investment and can only be done on average once per 25 years when the farmer's current stable is depreciated (Gocsik, van der Lans, Lansink, & Saatkamp, 2015).

Dutch pig farmers, including those in Noord-Brabant, interact through study groups and farmer organisations (Tepic et al., 2012). Study groups are geographically formed, and vary in size from small groups of 5-15 farmers to large study groups of 15-35 farmers. In the smaller groups, farmers have intense contact and share technical and financial results. In the larger groups, farmers have the opportunity to learn from companies and research institutes. Organic and conventional pig farmers generally have their own study groups to maximise learning. Study groups have merged over the years due to decreasing numbers of participants. Some pig farmers active in study groups or farmer organisations are well-known to many pig farmers who themselves do not know as many farmers. Pig sector news, such as price information, latest innovations or knowledge, and farmers' experience, is spread via farmer magazines and websites. These magazines have nine to eleven editions per year and run around 3000 copies per edition, reaching around 70% of the Dutch pig farmer population (Pigbusiness, 2018; van der Meulen, 2020; Varkens.nl, 2020).

4.4.2 MODEL DESCRIPTION

The agent-based model was built in Netlogo version 6.0.2. The model distinguishes two types of agents: farmers and markets. Farmers differ from each other in e.g. innovativeness, market, farm size, farming style, and the status within the farming style reference group (see Appendix 4.A for an overview of all state variables). All farm sizes are modelled, i.e. from 'farms' with one pig to farms with 5000+ pigs, because small hobby farms might contribute to the image of organic as idealistic and non-professional. The transition process from farmer to successor is ignored here and we assumed that a successor can on average financially own the farm at the age of 37 years. Farmers retire at the age of 67 years in the Netherlands. There are two market agents: an organic and a conventional market agent. Markets differ from each other in average costs per pig, m2 indoor and m2 outdoor required per pig, and meat price (see Appendix 4.B for more information).

Farmers are connected in a directed network. This means that some farmers are known by many other farmers, while they do not know all these farmers in return (see ODD+D, in preparation). The primary time-step is one month. Some mechanisms play a role once per year, so they are executed every twelve steps.

The farmers' decision procedure to convert markets goes as follows. Every simulated year, farmers update their attitude towards the two markets in three ways: farmer-to-farmer interaction, news interaction, and effects of own income. Farmer-to-farmer interaction only happens through the farmers' existing network. News interaction represents an interview with a farmer in a pig farmer magazine. Effects of own income, represents the farmers' experience in the current market. If the most positive attitude exceeds a threshold, that market becomes the desired investment if it is not already the market the farmer produces for. The farmer then collects information on technical and management results of the desired market from other farmers producing for that market. With that information the farmer calculates the expected income for the next 5 years of the desired market. If the expected average income is the same or higher than the average income over the past 5 years in his current situation, the farmer converts.

Every month, (1) all farmers interact with one random farmer in their network, (2) all farmers check whether they have a desired investment, and (3) if farmers have a desired investment, they collect information from one random other farmer producing for his desired investment and (4) 70% of farmers interact with one and the same farmer, chosen randomly. Every year, at the end of the year, the age of the farmers is updated. Then

farmers check whether they retire and whether they have a successor. They update their income and update their entrepreneurial status (which is based on income). If they have a desired investment, they check whether it is profitable to convert at this moment and if so, they convert and update their variables accordingly. Model outputs were derived after 180 time steps corresponding to 15 years, which represent the time from January 2000 to December 2015. The remainder of this section outlines the interaction mechanism, retirement and succession mechanism, income calculation, and market price dynamics (for more details see ODD+D, in preparation).

4.4.2.1 SOCIAL STRUCTURE OF FARMER AGENTS

Influence in interaction is determined by four farmers' reference groups: (1) farmers who are similar in farming style; (2) farmers who are similar in farm size; (3) farmers who are similar in market; and (4) farmers who have a high status according to one's own farming style reference group. Thus, only for the farmers' farming style reference group, the status symbols are operationalised (see Table 4.1.). Furthermore, farmers are connected in a directed network. The network of farmers differs from the four reference groups, because it includes farmer neighbours next to the farmers' reference groups (see ODD+D, in preparation). Farmers' neighbours represent the farmers in the study group. Apart from interactions by news, farmers are only influenced by other farmers to whom they have a network link.

4.4.2.2 INTERACTION MECHANISM

The topic (organic or conventional) for interaction is randomly chosen per interaction. When farmer A interacts with farmer B, the effect of the interaction on farmer A depends on the credibility of farmer B to farmer A. The perceived credibility of farmer B depends on a number of factors: the innovativeness of farmer A, the farming styles of farmer A and farmer B, the status farmer A assigns to farmer B according to farmer A's farming style reference group, the farm sizes of farmer A and farmer B, and the markets of farmer A and farmer B. Following the Social Identity Approach, the status of farmer B as well as the similarity in farming style reference group and farm contextual reference groups (i.e. farm size and market) between the two farmers matter for the perceived credibility of farmer B. The basic idea is that an innovative (or less conformist) farmer A considers the status of farmer B more than considering the similarity between them. While a conservative (or

more conformist) farmer A considers the similarity between them more than the status of farmer B. This results in the formula given in equation (1) below. For the calculation of the status value and the similarity value see equations (2) and (3) respectively.

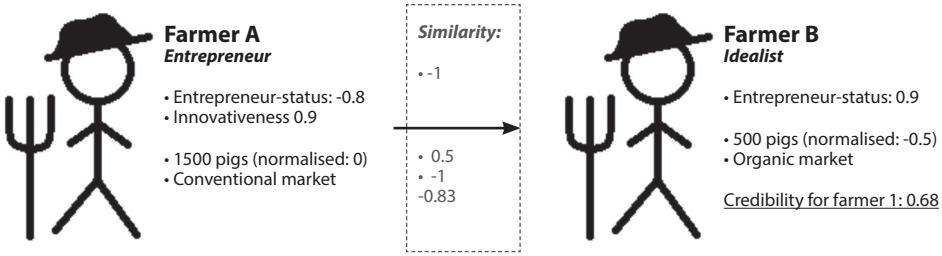

FIGURE 4.1. Example of an interaction between farmer A and farmer B, including the factors that are important, their value, and the resulting perceived credibility of farmer B perceived by farmer A

Each farmer has three statuses: idealist-status, craftsmen-status and entrepreneur-status. In interaction, farmer A compares the status relevant for his own farming style reference group with the status of farmer B relevant for A's reference group. The higher the status of farmer B compared to the status of farmer A, the higher farmer B's credibility in the eyes of farmer A (see Figure 4.1. for an example of this calculation). The similarity value is comprised of personal and farm similarities: similarity in reference group (personal), similarity in market (farm), and similarity farm size (farm). The more similar, the higher the perceived credibility of farmer B (and even more so when farmer A is conservative); see equation (1).

$$C = I_A * S + (1 - I_A) * G \qquad (1)$$

C = Credibility of farmer B (in the eyes of farmer A)
I_A = Innovativeness of farmer A
S = The relative status of farmer A; see equation (2)
G = The similarity value; see equation (3)

The credibility of farmer B has to exceed a negative/positive 'credibility threshold' for influence on farmer A to be negative/positive. Otherwise, there will be no influence. If there is influence, the influence is either negative or positive. A positive influence means that the attitude of farmer A will go in the direction of the attitude of farmer B, while a negative influence means that the attitude of farmer A will move away from the attitude of farmer B. The more credible, the stronger the influence; see equation (4). Any change to attitude values will be restricted to a minimum of 0 and a maximum of 1.

The status value is calculated according to the following formula:

$$St = -1 * (S_A - S_B) * 0.5 \quad (2)$$

St = Status value of farmer B perceived by farmer A
S_A = Status of farmer A for his reference group
S_B = Status of farmer B for reference group of farmer A

The similarity value is calculated as follows:

$$G = Wr * R + Wm * M + Wf * F \quad (3)$$

G = The similarity value of farmer B perceived by farmer A
Wr, Wm, and Wf = the relative weights for similarity in reference group (Wr), market (Wm) and farm size (Wf) ($Wr + Wm + Wf$=1)
R = reference group similarity (same reference group: 1; entrepreneurs vs. craftsman: 0; otherwise: -1)
M = market segment similarity: same market: 1; different markets: -1
F = farm size similarity (i.e. 1 - $|F_A - F_B|$, where F_A and F_B are adjusted to a value between -1 and 1 (i.e. -1 represents the smallest farm in the model, 1 the largest farm size in the model)

The level of influence is calculated as follows:

$$\begin{aligned} &\text{if } C < x_1: && Li = M_i * N_a * (1-\Delta A) && (4)\\ &\text{if } C > x_2: && Li = M_i * N_a * \Delta A \\ &\text{if } x_1 \leq C \leq x_2: && Li = 0 \end{aligned}$$

x_1 = credibility threshold for negative attitude influence

x_2 = credibility threshold for positive attitude influence

Li = The level of influence

M_i = a constant that defines the magnitude of influence: the percentage with which the difference in attitudes between the two farmers can be overcome

N_a = The normalised credibility (C), i.e. the credibility is adjusted to a number between 0 and 1 (from a number between -1 and 1)

ΔA = the absolute difference in attitude between farmer A and farmer B.

Note that the mechanism used for one-to-one interactions applies for the interpretation of 'news' as well.

After interaction, farmers check whether they have a desired investment and would like to change markets. First the farmer checks which attitude is most positive (organic or conventional attitude), then the farmer checks whether that attitude exceeds a threshold. If it exceeds the threshold, the respective market becomes a desired investment if it is not the market the farmer already produces for.

4.4.2.3 RETIREMENT AND SUCCESSION

Succession is the only procedure through which 'new' farmers enter the model and through which change in reference groups is possible. Each year each farmer checks whether s/he has the age to retire (67). If s/he retires, the farmer has a chance to have a successor. This depends on a random factor for 50%, and on the farmer's average income over the past five years for the remaining 50%. The lower the average income compared to the modal income of all farmers, the smaller the chance (see equation 5). If the farmer has a successor, the model sets his/her age, innovativeness, management and technical efficiency factors, and network according to the corresponding initialisation parameters

(for more details see ODD+D, in preparation). The reference group of the successor is determined by a predefined chance (parameter 'probability successor has the same farming style as the predecessor') that the successor has the same reference group as his predecessor. If it is not the same, the reference group is randomly selected. At last, the market attitudes are re-initialised. This is for 90% derived from the attitude of his best friend and for 10% randomly. The best friend is a connected farmer who is most similar to him in terms of reference group and age.

$$P_x = \frac{1}{1 + exp^{-x/a}} \qquad (5)$$

P = Probability successor wants to take over the farm based on the average income of the farm over the past 5 years
x = The difference between the average income of the farmer over the past five years and the modal income
a = a parameter to adjust the income in the model to a representative value for the successor to evaluate the income of the farm

4.4.2.4 INCOME CALCULATION

The main principle behind income calculation of farmers is that (1) differences in income between farmers is dependent on technical efficiency (Gocsik, Oude Lansink, Voermans, & Saatkamp, 2015) and management efficiency (Commandeur, 2006; de Rooij et al., 2010), and (2) that there is a representative difference in average cost and meat price between conventional and organic markets. For this, the model contains parameters for initial meat prices, average costs per pig, and rotation speed in conventional and organic markets as specified in the model by Gocsik et al. (2015) (see Appendix 4.B). Farm income is derived based on the following formula:

$$I_t = (W * P_{t,m} - C_m * x) * (N_t * r_m) \qquad (6)$$

I_t = Annual farm income (in euro)
W = Average carcass weight per pig in kg
$P_{t,m}$ = Farm gate price (in euro) per kg meat in year t of market segment (m = *org* if organic; m = *conv* if conventional)

C_m = Average cost price per pig of market segment (in euro)
N_t = The number of pigs of the farmer agent at time t
r_m = Rotation speed (number of rounds of fattening pigs per year) of market segment
x = Efficiency factor of the farmer agent (for range see farmer initialisation variables in Appendix 4.A)

The two markets have different price mechanisms. Meat price on the conventional market is volatile over time according to a closed-form expression for price $P_{conv,t}$ adopted from Gocsik et al. (2015); see equation (7). For the organic market we assumed a constant elasticity demand function for organic meat. Additionally, we assumed a constant trend for demand of organic meat; see equation (8). Refer to the appendix 4.C for equation 8's derivation.

$$P_{conv,t+1} = P_{conv,t} + e^{\sigma\varepsilon+(\mu-0.5\sigma^2)} \quad (7)$$

$P_{conv,t+1}$ = Price per kg of conventional meat in year t *(in euro's per kg)*
σ = constant
ε = an independent and identically distributed standard normal random variable
μ = constant

$$P_{org,t+1} = a * \frac{Q_{org}^{1/-E}}{T^t} \quad (8)$$

$P_{org,t+1}$ = Price per kg of organic meat in year t *(in euro's per kg)*
T = A constant that represents the annual increase in demand
E = Price elasticity[2] of organic meat
a = constant

Note that the nature of the demand function is such that when extra supply is bigger than the increase in demand, a high price elasticity results in a steep decrease in price and a low price elasticity results in a small decrease in price (see Table 4.2.).

[2] A high price elasticity means that a small change in price results in a large change in demand, whereas a low price elasticity (i.e. inelastic price elasticity of demand) means that a small change in price results in a small change in demand.

TABLE 4.2. The effect of a high versus low price elasticity in scenarios where the extra organic supply exceeds or does not exceed the increase in organic demand, on the organic price

Scenarios		
Trend in demand (ΔD_{org}) versus change in supply in model (Q_{org})	*A low or high price elasticity*	*Effect on organic price (P_{org})*
If $\Delta D_{org} > Q_{org}$	Low price elasticity	Small increase in price
	High price elasticity	Steep increase in price
If $\Delta D_{org} < Q_{org}$	Low price elasticity	Small decrease in price
	High price elasticity	Steep decrease in price

4.4.3 SENSITIVITY ANALYSIS

Two categories of outputs were selected for the sensitivity analyses: the size of the organic market, i.e. the number of organic farmers and organic pigs; and the shares of farming styles in the organic market, i.e. the number of idealists, craftsmen and entrepreneurs in the organic market. First an exploratory analysis on the sensitivity of the model outputs to the social influence parameters was done. The social influence parameters were: (1) the credibility thresholds: the level of credibility another farmer needs to have before it leads to social influence; (2) the weights of the factors that determine similarity: the weight of farm size, market and reference group were each set to zero in turn; and (3) the magnitude of influence once the credibility of the farmer exceeds the threshold (see Table 4.3.).

TABLE 4.3. Three groups of scenarios of the social influence parameter settings for an exploratory analysis of its effects on model outcomes. The base scenario can be seen as belonging to all groups as "Threshold 0.5", "Similarity Base", and "Magnitude of influence 1.0", respectively

	Scenarios for social influence parameter settings										
		Threshold			Similarity			Magnitude of influence			
Name parameter	**Base**	**0.75**	**0.25**	**0**	**xF***	**xM***	**xR***	**0.8**	**0.6**	**0.4**	**0.2**
Thr. lack of credibility (-1 – 0)	-0.5	-0.75	-0.25	0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Thr. credibility (0 – 1)	0.5	0.75	0.25	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Weight farm size (0-100)	50	50	50	50	0	50	50	50	50	50	50
Weight market (0-100)	50	50	50	50	50	0	50	50	50	50	50
Weight ref group (0-100)	50	50	50	50	50	50	0	50	50	50	50
Magnitude of influence (0-1)	1	1	1	1	1	1	1	0.8	0.6	0.4	0.2

** xF = scenario where weight farm size is set to zero, xM = scenario where weight market is set to zero; xR = scenario where weight reference group is set to zero*

After the exploratory analysis, a full local sensitivity analysis was performed for three selected scenarios: a low threshold scenario (L = Threshold 0.25), the base scenario (B = Base = Threshold 0.5), and a high threshold scenario (H = Threshold 0.75). The full sensitivity analysis covered all model parameters as specified in Table 4.4. For each combination of parameter p and output variable v, the relative sensitivity of output v to parameter p was computed as:

$$\frac{v_2 - v_1}{p_2 - p_1} \Big/ \frac{|v_s| + (|v_1| + |v_2|) / 2}{|p_s| + (|p_1| + |p_2|) / 2} \qquad (9)$$

where:

p_s is the scenario value of parameter p

p_1 is the low value for SA of parameter p

p_2 is the high value for SA of parameter p

v_s is the average output value of v for replicated runs with all parameters set to their scenario values

v_1 is the average output value of v for replicated runs with (only) parameter p changed to value p_1

v_2 is the average output value of v for replicated runs with (only) parameter p changed to value p_2

TABLE 4.4. Parameter settings for the full local sensitivity analysis (SA) of the three selected scenarios

Name parameter in model		Range	Scenario value: p_s	Low value for SA: p_1	High value for SA: p_2
Thr. lack of credibility (x_1 in equation 4)	**[L: Low threshold scenario]**	**-1 - 0**	**-0.25**	**-0.3**	**-0.2**
Thr. credibility (x_2 in equation 4)		**0 - 1**	**0.25**	**0.2**	**0.3**
Thr. lack of credibility (x_1 in equation 4)	**[B: Base scenario]**	**-1 - 0**	**-0.5**	**-0.55**	**-0.45**
Thr. credibility (x_2 in equation 4)		**0 - 1**	**0.5**	**0.45**	**0.55**
Thr. lack of credibility (x_1 in equation 4)	**[H: High threshold scenario]**	**-1 - 0**	**-0.75**	**-0.8**	**-0.7**
Thr. credibility (x_2 in equation 4)		**0 - 1**	**0.75**	**0.7**	**0.8**
Weight farm size (*Wf* in equation 3)		0-100	50	45	55
Weight market (*Wm* in equation 3)		0-100	50	45	55
Weight reference group (*Wr* in equation 3)		0-100	50	45	55
Magnitude of influence (*Mi* in equation 4)		0 - 1	1	0.9	0.95
Probability a farmer collects information on desired market		0 - 1	0.5	0.55	0.55
Elasticity of demand for organic meat price (*E* in equation 8)		no range	-1.13	-1.14	-1.12
Trend in demand (*T* in equation 8)		no range	5	4	6
Probability successor has the same farming style as the predecessor		0 - 100	50	45	55
Number of peers on which successor bases his attitude		1 - 10	1	0	2
Threshold attitude for investment		0 - 1	0.8	0.75	0.85
Maximum attitude update based on income		0 - 0.5	0.2	0.15	0.25
% of farmers that receive news		0 - 100	70	65	75
Chance that the other market is in the news		0 - 50	25	20	30
Chance that information seeking behaviour is the same for all farmers or based on a farmer's innovativeness		0 - 1	0.5	0.45	0.55
Number of years for a stable to be depreciated		no range	25	24	26
Fraction of successor's attitude which is based on successor's peers		0 - 1	0.9	0.85	0.95
Income scaling factor (*a* in equation 5)		no range	30000	28000	32000

For each parameter setting, for the exploratory analysis as well as the sensitivity analysis, the runs were replicated 1000 times with different random seeds. Initially, the base scenario was replicated 20000 times. By comparing increasingly large subsets of these runs, following the guidelines by Troitzsch (2014), we found that variances of outputs stabilises between 600 and 900 replications. Therefore, a replication factor of 1000 was used for all runs.

We ranked the most influential parameter per output, and then we summed the ranks for each parameter over the (threshold) scenarios L, B, and H per category of output. This gives an overall rank for the most influential parameters per category of output. Two category of outputs are distinguished: size of the organic market (i.e. number of organic pigs and number of organic farmers), and the diversity of farming styles in the organic market (i.e. number of organic idealists, organic craftsmen and organic entrepreneurs). We use the term 'diversity' for this measurement, because at initialisation there are only organic idealists: organic craftsmen and organic entrepreneurs increase the diversity of farming styles in the organic market. In the results section we discuss the influential parameters per category of output.

4.4.4 MODEL VALIDATION

Finally, the model results were discussed with three selected experts of the Dutch organic pig sector for validation (Gilbert, 2019). The three experts were a pig sector economist, an organic slaughterhouse farm manager and an organic feed advisor. They were selected based on their experience in the organic pig sector over the past 20 years. The interviews were organised according to the following principles: questions focused on validation of results, not on validation of assumptions; necessary information was presented before questions were asked, such as what is price elasticity and what do we consider farmer types; experts were asked about their expectations before model results were presented; and experts were asked to reflect on model results (see Appendix 4.G for more details).

4.5 MODEL RESULTS

4.5.1 RESULTS OF EXPLORATORY ANALYSIS

We explored the effect of three categories of social influence parameters on all selected outputs: two credibility threshold parameters ('threshold lack of credibility' and 'threshold credibility'); three similarity parameters ('weight farm size', 'weight market' and 'weight reference group'). The two credibility threshold parameters have the most impact on all selected outputs (see Appendix 4.D. and 4.8.E). The magnitude of influence (referred to as 'magnitude of influence' parameter) has hardly any effect on model outputs. As for the similarity parameters, only the 'weight reference group' parameter has an influence on the diversity of the farming styles in the organic market: when this parameter is set to zero, the number of organic farmers with a craftsmen and entrepreneurial farming style increases and there is a more equal distribution of farming styles among organic farmers (see Appendix 4.E.). The other two similarity parameters, 'weight farm size' and 'weight market', do not affect the outputs.

4.5.2 RESULTS OF SENSITIVITY ANALYSIS

Overall, the results show that (1) when the thresholds for credibility become stricter (i.e. value for 'threshold lack of credibility' is set closer to -1 and value for 'threshold credibility' is set closer to 1, their influence on the size of the organic market become higher; (2) parameters that influence information seeking behaviour after a farmer considers conversion (see parameters 'chance farm collects info market' and 'chance info seek beh/based innovative' in Appendix 4.F.), have hardly any effect on the size of the organic market; (3) whether a successor bases his attitude on one or more neighbours does not matter (see parameter '#peers successor bases attitude' in Appendix 4.F.) ; and (4) news plays an important role only in scenarios L and B on the size of the organic market and on the number of organic idealists (see parameters '% farmers that receive news' in Appendix 4.F.). The three most influential parameters per category of output are discussed in more detail below. Note that the three most influential parameters are the most influential parameters overall over the three threshold scenarios per category of output, while per threshold scenario and per output, the most influential parameters can differ (see Tables 4.5. and 4.6.). The differences per threshold scenario and outputs are outlined below.

4.5.2.1 SIZE OF ORGANIC MARKET

The most influential parameters (two parameters share the third place, see Table 4.5.) on the number of organic farmers and the number of organic pigs are (in descending order) the price elasticity of demand for organic meat (referred to as 'price elasticity' parameter from now on), whether the successor bases his/her attitude on his/her peers or on a random variable (referred to as 'successor peer' parameter from now on), whether the successor has the same reference group as his/her predecessor (referred to as 'successor farming style' parameter from now on), and the threshold for lack of credibility (referred to as 'discredibility threshold' parameter from now on). The influence of the 'price elasticity' parameter on the number of organic farmers and pigs is positive in scenarios L and B when extra supply exceeds the trend in demand, while negative in scenario H when the trend in demand exceeds extra supply. The 'price elasticity' is most influential in scenario B, and less influential in scenarios L and H when there are great differences in supply and demand. The influence of the 'successor peer' parameter on the number of organic farmers and pigs is negative in scenario B. This indicates that peers are more negative towards organic than a random variable. The influence of the 'successor peer' parameter on the number of organic farmers and pigs is positive in scenarios L and H. This indicates that peers are more positive towards organic than a random variable. In scenario B, this parameter is less influential on the number of organic pigs, not number of organic farmers, compared to the other scenarios. The influence of the 'successor farming style' parameter on the number of organic farmers and pigs is always negative. This means that if the chance with which the successor has the same reference group as his/her predecessor increases, the number of organic farmers and pigs decreases. This parameter is most influential in scenario B, and least influential in scenario H. Finally, the influence of the 'discredibility threshold' parameter on the number of organic farmers and pigs is always positive. This means that if the threshold decreases, i.e. another farmer needs to have a very low credibility for negative influence to take place, the number of organic farmers and pigs decreases. This parameter is more influential in scenarios L and H than in scenario B.

TABLE 4.5. The top three most influential parameters on the size of the organic market on average over the three threshold scenarios

	Sensitivity of output on parameter [a]												Sum rank of parameters	Rank on average
	number organic farmers						number organic pigs							
Parameter name	**L[b]**	**R[c]**	**B[b]**	**R**	**H[b]**	**R**	**L**	**R**	**B**	**R**	**H**	**R**		
Elasticity of demand for organic meat price	0.43	5	0.95	1	-0.60	5	0.81	2	1.15	1	-0.66	5	19	1
Fraction of the successor's attitude which is based on successor's peers	0.49	2	-0.41	3	1.66	3	0.53	3	-0.48	6	1.76	4	21	2
Probability successor has the same farming style as the predecessor	-0.46	4	-0.58	2	-0.29	10	-0.52	4	-0.65	2	-0.20	11	33	3
Threshold lack of credibility	0.46	3	0.09	12	2.10	2	0.50	5	0.29	8	2.26	3	33	3

[a] *Sensitivity of the output to a small change in parameter*

[b] *Scenario names: L = Low threshold scenario; B = Base scenario; H = High threshold scenario (see Table 4.4.)*

[c] *R = Rank of the influence of the parameter on the output (where 1 = most influential)*

4.5.2.2 SHARE OF REFERENCE GROUPS IN THE ORGANIC MARKET

The three most influential parameters on the number of idealists, craftsmen and entrepreneurs in the organic market are the 'price elasticity' parameter, the 'discredibility threshold' parameter, and the investment threshold parameter that states the minimum value that a farmer's attitude should have for him/her to consider the investment (referred to as 'threshold investment' parameter from now on). The positive versus negative influence of the 'price elasticity' parameter on the number of organic idealists in the different scenarios is exactly the same as it is on the size of the organic market: positive in scenarios L and B, negative for scenario H. For the number of organic craftsmen, the influence of 'price elasticity' is always positive, and for organic entrepreneurs it is negative in scenarios L and H and positive in scenario B. The 'price elasticity' parameter is most influential on the number of organic entrepreneurs, and most influential in scenarios L and B on the number of organic craftsmen and organic idealists. The influence of the 'discredibility threshold' parameter on the number of organic craftsmen and organic entrepreneurs is positive in all scenarios, while its influence on the number of organic idealists is only positive in scenario H and negative in scenarios L and B. This means that when farmers are less likely to negatively influence each other, the number of organic craftsmen and entrepreneurs always go up, while for idealists this only counts for scenario H. The 'discredibility threshold' is most influential in scenario H on the number of organic idealists, most influential in scenarios L and B on the number of organic craftsmen and most influential in scenario B on the number of organic entrepreneurs.

The influence of the 'threshold investment' parameter also differs per scenario and per output. It is positive on the number of organic idealists in scenarios L and B and it is positive on the number of organic entrepreneurs in scenarios B and H. In all cases where this parameter is negative, it means that for a lower threshold (i.e. farmers are more willing to invest in the market) more idealists, craftsmen, and/or entrepreneurs enter the organic market.

TABLE 4.6. The top three most influential parameters on the diversity of farming styles in organic market over the three threshold scenarios

	Sensitivity of output on parameter [a]																		Sum rank of parameters	Rank on average
	number idealists in organic						number craftsmen in organic						number entrepreneurs in organic							
Parameter name	**L[b]**	**R[c]**	**B[b]**	**R**	**H[b]**	**R**	**L**	**R**	**B**	**R**	**H**	**R**	**L**	**R**	**B**	**R**	**H**	**R**		
Elasticity of demand for organic meat	0.52	1	0.39	2	-0.61	5	1.43	3	25.74	1	0.74	4	-6.93	1	1.74	2	-1.48	1	20	1
Threshold attitude for investment	0.21	6	-0.11	11	-1.28	4	-1.80	2	-1.05	10	-0.49	5	-2.55	4	1.13	4	0.86	4	50	2
Threshold lack of credibility	-0.18	7	-0.10	12	2.14	2	2.24	1	7.50	2	0.12	14	1.52	9	1.79	1	0.78	5	53	3

[a] Sensitivity of the output to a small change in parameter
[b] Scenario names: L = Low threshold scenario; B = Base scenario; H = High threshold scenario (see Table 4.4.)
[c] R = Rank of the influence of the parameter on the output (where 1 = most influential)

4.5.3 EXPERT VALIDATION

The experts were asked to reflect on three model results (see Appendix 4.G.). First the experts reflected on what they thought were the three most important factors that influenced the size of the organic market among farmers over the past 20 years and relate their thoughts to the model results. Second, they were asked to reflect on the role of price elasticity of organic pork meat demand and its relation to the size of the organic market. Finally, the experts were asked to reflect on the diversity of farming styles in general, in the organic market, and on the model results.

4.5.3.1 THREE MOST IMPORTANT FACTORS FOR THE SIZE OF THE ORGANIC MARKET

All experts thought market factors to be the most important factor for the size of the organic market. Their explanations were different: one argued that farm gate price stability in the organic market is the most important factor (price stability is regulated partly by a waiting list of the slaughterhouse for conventional farmers who want to convert), and two thought demand by consumers would be most important (see Table 4.7.). Experts differed on the second most important factor. One expert thought that this was social influence among farmers, another expert thought social influence among consumers (not included in the model), and the third expert thought that shocks or events in the conventional market was the second most important factor. The third most important factor, according to all experts, was farm succession through their successors. According to these experts, most recently converted organic farmers are young farmers who think differently than their predecessors.

TABLE 4.7. Top three most important factors that influence the size of the organic market according to model results and experts.

	Model results	Expert 1	Expert 2	Expert 3
1	Price elasticity of demand	Farm gate price stability	Consumer demand	Consumer demand
2	Successors' peers	Social influence among farmers	Social influence among consumers	Events in the conventional market
3	Successors' farming style	Successors think differently than their predecessors	Successors think differently than their predecessors	Successors think differently than their predecessors

4.5.3.2 PRICE ELASTICITY

All experts found it hard or irrelevant to reflect on whether a price inelastic or a price elastic demand of organic pork meat resulted in an increase in the size of organic farming in the past. Two of them thought that for most organic meat, consumer demand is inelastic (an increase in price will not affect demand). These experts argued that organic consumers already decided to pay twice as much for their pork meat, a slight price increase would not influence their demand. Although they mentioned that the price should not increase much further. One expert thought that organic pork meat consumers can be divided in two groups: one for which the price is elastic and one for which the price is more inelastic. The question was found irrelevant by one expert because the price of organic pork meat is kept stable over time by supermarkets. The others argued that increase in demand is more important than price changes. In reality, according to all experts, supply is more often in excess than demand, which determines the margin. Excess supply is absorbed in the European organic pork meat market and the loss in margin is distributed among supply chain actors. This means that excess supply indeed affects the profitability of organic farming through a decrease in farm gate price, but that consumer prices are not affected by imbalances in supply and demand.

Experts mentioned in addition that conventional farmers are not knowledgeable about the margin on organic pigs (i.e. the farm gate price for organic pigs and the cost price of production), only via farm advisors or organic farmers. Experts argued that if a conventional farmer is aware of the farm gate price for organic pigs, that farmer is already interested in conversion to organic. Farmers can become aware of an increase in demand of organic pork meat via media channels. In the past, the number of organic pig farmers increased during two specific periods, according to one expert. Both were related to increases in demand.

4.5.3.3 FARMING STYLE DIVERSITY IN THE ORGANIC MARKET

All experts are familiar with the farming styles used in the model. All argue that at the start of the organic market (from roughly 1980s till 2000) organic farmers were idealists. In the course of time, organic farmers consisted of craftsmen and a couple of entrepreneurs next to idealists. Experts gave two explanations for the increase in craftsmen in the organic market: more craftsmen entered the organic market or craftsmen characteristics in the farmers became more dominant over time. Still, most organic farmers have some

idealism in them. The experts recognised that the 'idealistic' reputation of the organic sector disappeared around 2010. This reduced the obstacle for conventional farmers to convert. They argued that the disappearance of this reputation went together with a higher appreciation of organic food in society. In addition, the experts mentioned that the disappearance of the 'idealistic' reputation of organic farming did not lead to an increase in organic farming, because organic demand limited organic supply.

4.6 DISCUSSION

This research aimed to gain insight in what factors influence the size of organic pig farming (i.e. number of organic farmers and number of organic pigs) and the diversity of farming styles among organic pig farmers, by taking into account social influence mechanisms, market price dynamics and farmer heterogeneity. The sensitivity analysis showed that the most influential factors on the size of the organic market are price elasticity of demand in interaction with the parametrisation of social influence, the successors' farming style and the successors' peers. The most influential factors on the diversity of farming styles in the organic market were social influence parameters. When idealists, craftsmen and entrepreneurs do not perceive each other as out-groups, but instead as reference group, diversity of farming styles in the organic market increases. In addition, when the credibility of another farmer does not need to be high for influence in interaction to take place, diversity of organic farmers' farming style increases, and the distribution in farming styles in the organic market becomes similar to the distribution in the conventional market.

4.6.1 MARKET FACTORS

The threshold scenarios showed that the likelihood for influence in interaction (thresholds for credibility) determined whether a low or high price elasticity is favourable for the growth of organic farming: in scenarios L and B more farmers were influenced in interaction, and more farmers converted to organic farming. This caused a higher increase in organic supply than there was increase in demand. In this case a low price elasticity was favourable for the growth of organic farming. In scenario H, fewer farmers were influenced in interaction, and fewer farmers converted to organic farming. This

caused a lower increase in supply than there was increase in demand. In that case a high price elasticity is favourable for the growth of organic farming. Experts argued that the most important factor for growth in organic farming is consumer demand for organic meat instead of price elasticity of demand, because consumer prices hardly fluctuate due to supermarkets' price policy. In addition, they argued that gains or losses caused by imbalances in supply and demand are taken by supply-chain actors instead of consumers.

Two conclusions are drawn from these results. First, the model results in combination with expert discussion indicate the importance of consumer demand for the diffusion of organic farming. This is in contrast with previous studies that focus solely on understanding the importance of individual farm or farmer characteristics (De Cock, 2005; Parra-Lopez, De-Haro-Giménez, & Calatrava-Requena, 2007), and that do not account for consumer demand in studying diffusion of alternative market strategies (Deffuant et al., 2002; Olabisi et al., 2015; Xu et al., 2018). The importance of consumer demand is supported in previous research by Smith & Marsden (2004) who also draw attention to this. By including market demand the importance of individual farmer behaviour diminishes, though not disappears. This finding supports previous studies that argue that it is important to go beyond the individual and include the wider agricultural system, its actors and components, in understanding diffusion processes of alternative farming strategies (Rose, Keating, Vrain, & Morris, 2018; Smith & Marsden, 2004).

Second, the results show that social interaction dynamics between farmers are important, because they affect the profitability of alternative market strategies through imbalances in supply and demand in the absence of supply regulation by a slaughterhouse. This points out that it is important to better understand the role of interactions between farmers on the decision to convert. Since there is a general lack of data for the effect of social influence on conversion decisions, empirical research into social interaction as a 'trigger event' for conversion would be interesting, especially in the case of excess demand. Also, the importance of social influence parameters on excess supply or excess demand in this model, support the argument made by Flache et al. (2017) that in agent-based models attention should be paid to the technical implementation of interaction between agents and the sensitivity of the outcome on the parameterisation of the interaction mechanism. Finally, in this research we used a predefined network for farmers and predefined characteristics for farmers and markets, including the distribution of markets and farming styles. Future empirical research on farmers' characteristics including their

network and/or sensitivity analysis on the instantiation of market parameters and the pig farmer population including their network can give more insight in the effects of different initial situations on diffusion of added-value markets.

Finally, in our model the formula for farm gate price of organic pigs is based on a price elasticity of demand measured in 2006 and on the assumption that consumer price is affected by producer supply. However, experts argued that losses and gains of imbalances in supply or demand are taken by farmers, slaughterhouses and/or retailers instead of consumers. Hence, increase in demand, influenced by price or not, is more important than price elasticity of demand. This means that over-supply indeed affects the profitability of organic farming, but that price elasticity of consumer demand might not be the best indicator for this dynamic. In addition, organic supply is currently regulated for a large part by one organic slaughterhouse: farmers who want to convert in case of excess supply are put on a waiting list and farm gate prices are kept relatively stable over time. It should be noted that the individual consideration of expected price stability was not included in this model, while one expert mentioned this to be important, because some farmers take this into consideration for farm continuity. This is an interesting point for further study. When the organic market grows in size, however, regulation becomes harder, and price elasticity of demand becomes a better indicator for profitability of organic farming. Therefore, price elasticity of demand remains an important area for research. Since supermarkets keep the price of organic meat stable and price elasticity of demand is influenced by many factors and in constant development (Bielik & Šajbinorová, 2009; Delport, Louw, Davids, Vermeulen, & Meyer, 2017), it would be interesting to know whether the availability of substitutes and the price of substitutes (e.g. conventional meat and vegetarian alternatives) affect demand of organic meat. This requires additional research on price elasticity and cross price elasticities. In addition, it would be interesting to gain more insight in social influence mechanisms among consumers that affect demand of organic meat, given a static price, through e.g. agent-based modelling.

4.6.2 NEW ENTRANTS

This study showed that new entrants are important for the diffusion of organic farming. The influence of new entrants goes via two factors: their farming styles and their peer influence. More specifically, a higher chance that the successor has the same farming style as his/her predecessor leads to fewer organic farmers and pigs, irrespective of the parametrisation of the social influence mechanism in the model. This result was confirmed

by experts. Moreover, it is in line with previous research findings that associated organic farmers more often with an urban background (Padel, 2001), assuming that farmers with an urban background have a different farming style through different peers. It is also in line with social identity theory (Burton & Wilson, 2006), where successors have a higher chance for different farming styles than their predecessors through different reference groups. Interestingly, experts mentioned that young farmers seemed to have another rationale for converting than previous idealists, craftsmen or entrepreneurs who converted. This seems to indicate that young farmers adhere to a new farming style. The rationale used by the young farmers, mentioned by experts, fits the constructivist discourse identified by De Rooij et al. (2010). Farmers adhering to this discourse accept changes in societal norms regarding animal welfare and recognise the need to respond to this. More research in the farming styles of successors, including the diversity of farming styles and development of new rationales, would be interesting for gaining insight in diffusion of alternative farming practices. The importance of successors in conversion to organic is, however, in contrast with studies that found no correlation between age and early or late adopters of organic farming (Parra-Lopez et al., 2007), or between age and farmers with a conservation identity (Burton, 1998a). The role of successors in adoption of alternative farming practices might, therefore, be different per context.

4.6.3 DIVERSITY OF FARMING STYLES AMONG ORGANIC FARMERS

Two social influence parameters affected the diversity in farming styles among organic farmers in the model: the thresholds for influence and the similarity in reference group. A higher frequency of social influence (lower thresholds) increases the diversity of farming styles among organic farmers. Excluding similarity in reference groups for the credibility of another farmer also increases the diversity of farming styles among organic farmers. The latter means that when farmers with different farming styles do not see each other as out-groups - the idealistic reputation of organic farming does not obstruct conversion decisions or idealists can positively influence entrepreneurs and craftsmen - diversity of organic farmers' farming styles increases and the distribution of farming styles in the organic market becomes more equal. In the latter case, the question is whether conventional idealists (still) exist and whether they are connected to conventional craftsmen and entrepreneurs. Experts mentioned that it rarely happens anymore that farmers convert out of idealists motivations.

Experts did recognise the increase of other farming styles than idealists among organic farmers over the years. They also recognised the disappearance of the idealistic reputation of organic farming and organic food within society in general. According to these experts, craftsmen and some entrepreneurs entered the organic market, while most organic idealists changed from a dominant idealist rationale to a dominant craftsmen rationale to professionalise organic farming. This development suggests that the craftsmen and entrepreneurs who entered the organic market could have influenced the dominant reference group of idealistic farmers, which in turn decreased the idealist reputation. This development also suggests that farmers have multiple reference groups within them. This is supported by previous research and identity theory (Burton & Wilson, 2006; Howden & Vanclay, 2009). The social influence mechanism in the model by Xu et al. (2018) where farmers have multiple performance indicators could therefore be an interesting addition to the mechanism proposed in this model. Another explanation for the diversification of farming styles in organic is the societal acceptance of organic farming. Societal acceptance of organic farming could have resulted in an increase of status of organic farmers and/or a decrease in status of conventional farmers. This means that either new status symbols within reference groups could have emerged due to societal developments, or that a low status in one reference group leads to another salient reference group that guides behaviour.

Finally, the development of changes in farmers' rationale to convert to organic is identified by previous research (Padel, 2001; Parra-Lopez et al., 2007). The social influence mechanism proposed in this model is able to reproduce this pattern under specific conditions: high frequency of influence or excluding similarity in reference group. The social influence mechanism proposed in this model, together with the improvements suggested above (multiple reference groups within farmers and/or development of new status symbols within reference groups), could serve as suggestions for future work on social influence mechanisms and understanding the development of added-value markets.

4.6.4 POLICY IMPLICATIONS

If policy makers wish to promote alternative farming strategies, they have several policy instruments at their disposition. There are legal instruments for labelling and certification. There are financial instruments, such as payments for conversion and continued organic

production, investment grants, and biodiversity offsets to penalise intensive farming practices through taxes. Finally, there are communicative instruments that focus on changing social norms in society (Allen & Hof, 2019; Stolze & Lampkin, 2009; Van Kooten, 2019). The demand for organic pork meat can, currently, not be influenced by price: supply is largely regulated by an organic slaughterhouse and consumer prices are kept stable by supermarkets. This can have an influence on diffusion of organic farming, since consumers cannot respond to price changes, while price changes turned out be the most influential mechanism for diffusion of organic farming in this research.

Given the importance of price elasticity of demand for organic pork meat, two financial policy instruments can be suggested. Both need further research to support the policy instrument that best fits organic farming diffusion. First, structural payments to organic pig farmers can decrease the cost price for organic pigs. A decrease in production costs should lead to a decrease in farm gate price. At the same time supermarkets should lower consumer prices in reaction to a decrease in farm gate price. Given the high price elasticity of demand for organic pork meat (Bunte, van Galen, Kuiper, & Tacken, 2010), a lower consumer price for organic pork should lead to a high increase in demand for organic pork. Increase in demand then leads to increase in supply. A second policy direction would be to stimulate consumers to switch from conventional pork to organic pork. If we assume that conventional pork consumers can be triggered by price changes to start consuming organic pork, biodiversity offsets to penalise conventional pork can equalize prices between conventional pork and organic pork. This does require more empirical research into cross-price elasticities of organic meat in comparison to conventional meat.

Also, two communicative policy instruments can be interesting given the current regulated market. First, communicative policy instruments can be developed that target consumer demand by, e.g., explaining the benefits of organic farming to consumers as to try and change social norms among consumers in favour of organic pork instead of conventional pork. The second direction for policy is to focus on new entrants, as this might contribute to diversity in farming styles in the farmer population and therewith diffusion of alternatives. Communicative policy instruments can focus on improving the image of farming within society for the younger generation. Financial policy instruments can focus on easing the entrance of young farmers into the farmer population. Both are interesting directions to further explore.

4.7 CONCLUSIONS

In this research we built an agent-based model on organic market conversion by Dutch pig farmers, which includes farmer-to-farmer interaction and market price dynamics. The model is based on (pig) farmer decision-making literature, and research findings from simulation games with pig farmers and pork sector experts. The results showed that an increase in the likelihood for influence in interaction increases the size of the organic market and increases an the diversity of organic farmers' farming styles. Also, when farmers regard all other farmers irrelevant of farming style as a reference group, there is more diversity in organic farmers' farming styles. The sensitivity analyses showed that price elasticity of demand for organic pork meat in interaction with social influence dynamics is the most influential factor to stimulate diffusion of organic farming. This is followed by the importance of new entrants. New entrants can stimulate organic farming by adding new farming styles in the pig farmer population and through different peers than their predecessor. Expert validation showed that organic pork meat demand, given a stable consumer price, can limit or stimulate the diffusion of organic farming. In the absence of market regulation by supply chain actors, the likelihood for influence in interaction between farmers affect the profitability of organic farming through excess supply or excess demand.

ACKNOWLEDGEMENTS

We like to thank Dr. Eva Gocsik and Dr. ir. Helmut Saatkamp for their input on pig farmers' income calculations, explaining their model, and making it available for us to use. We would also like to thank Robert Hoste for making time to share his expert knowledge on the Dutch pork sector multiple times. Finally, we are thankful for the experts that made time to discuss the results of the model with us. This work was supported by the 'IP/OP' investment programme 'Complex Adaptive Systems' of Wageningen UR, the Netherlands.

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APPENDICES

APPENDIX 4.A. STATE VARIABLES OF FARMERS

TABLE 4.8. State variables of farmers

State variables	Range	Initialisation	Static or dynamic?
Innovativeness	0-1	Random-normal 0.5 0.2. 0 is conservative, 1 is innovative	Static
Age	37 - 67	Random	Dynamic
Market-name	Conventional or organic	1958 conventional farmers; 6 organic farmers (Biologica, 2003; CBS, 2000)	Dynamic
Number of pigs	1 – 5000+	1448220 conventional pigs; 2393 organic pigs (Biologica, 2003; CBS, 2000), fit to CBS (2000) data.	Static
Year last investment	1977 – 2000	Random	Static
Management efficiency factor	0 – 2	Random-normal 1 0.005	Static
Technical efficiency factor	0 – 2	Random-normal 1 0.005	Static
Entrepreneur-status	-1 – 1	Normalised relative income + normalised farm size	Dynamic
Craftsman-status	-1 – 1	Normalised technical efficiency factor	Static
Idealist-status	-1 – 1	Defined by market-name: - Niche: random-normal 0.8 0.1 - Conventional: random-normal -0.8 0.1	Dynamic
Reference group	Idealist; entrepreneur; or craftsman	1%, 30%, 69% of farmer population respectively; all organic farmers are idealists	Static
Attitude conventional	0 – 1	Niche farmers: random-normal 0.1 0.1 Conventional: random-normal 0.85 0.1	Dynamic
Attitude niche	0 – 1	Niche farmers: random-normal 0.85 0.1 Conventional craftsmen: "" 0.3 0.1 Conventional entrepreneurs: "" 0.1 0.1	Dynamic

APPENDIX 4.B. STATE VARIABLES OF MARKETS

TABLE 4.9. State variables of markets.

State variables	Range	Initialisation	Static or dynamic?
Name market	Conventional; or niche	1 conventional market; 1 niche market.	Static
Average costs per pig*	119.41 – 243.85	Conventional: 119.41; Niche: 243.85	Static
Rotation speed	2.82 – 3.09	Conventional: 3.09 Niche: 2.82	Static
Conversion costs per m2	370**	Conventional: 370; Niche: 370	Static
m^2 indoor per pig	0.8 – 1.3	Conventional: 0.8; Niche: 1.3	Static
m^2 outdoor per pig	0 – 1	Conventional: 0; Niche: 1	Static
Meat-price at initialisation	0 - ∞	Conventional: 1.27; Niche: 2.54	Dynamic
Meat price history per pig at initialisation***	0 - ∞	Conventional: 1.66 0.97 1 1.24 1.12 Niche: 2.92 2.11 2.23 2.28 2.54	Dynamic

** The average cost price for both niche and conventional is derived from the average net return to labour and management based on an average farm size of 2000 fattening pigs using the model of Gocsik et al. (2015).*
*** The conversion costs for conventional to niche and niche to conventional are in this model the same as opposed to the model by Gocsik et al. (2015) (Personal communication Hoste, 2017).*
**** The initial meat price history is derived from a random generator.*

Note: The standard deviation of the technical and management efficiency factors of the farmers is derived from the standard normal distributions for feed conversion, mortality rate, and daily growth that influence the spread in cost price among pig farmers (Gocsik et al., 2015).

APPENDIX 4.C. DETAILS FOR CONVENTIONAL AND ORGANIC MEAT PRICE EQUATIONS

4.C.1. CONVENTIONAL MEAT PRICE EQUATION

$$P_{conv,t+1} = P_{conv,t} + e^{\sigma\varepsilon+(\mu-0.5\sigma^2)} \quad (10)$$

$P_{conv,t+1}$ = Price per kg of conventional meat in year t (euros per kg)
$\sigma = 0.12$
$\varepsilon = 0.5$
$\mu = 0$

4.C.2. ORGANIC MEAT PRICE EQUATION

For the organic market we assumed a constant elasticity function for demand in organic meat:

$$P_{org} = a * \frac{Q_{org}}{T_{org}^{\ t}}^{1/\epsilon} \quad (11)$$

P_{org} = Farm gate price for organic meat (euros per kg)
a = constant
Q_{org} = Amount of organic meat produced in North Brabant that can be sold for P_{org}, i.e. demand for organic meat (kg)
ϵ = Elasticity of demand for organic meat to the market price for organic meat
T_{org} = Trend in organic demand per year.

We assume that (1) price elasticity ϵ =-1.13 following Bunte et al. (2010); (2) T_{org} is 1.05, i.e. a 5% yearly increase in demand in organic meat, following Verhoef (2005); (3) in 2000 $P_{conv}^{\ 2000} = 0.5 * P_{org}^{\ 2000}$ following Gocsik et al. (2015)' assumption on the relation between conventional and organic meat prices, with $P_{conv}^{\ 2000} = 1.27$; (4) in 2000 16% of organic farmers and 26% of organic pig places in the Netherlands were in the province of North Brabant, i.e. average % over the years 2011-2019 (CBS, 2020b, 2020a); (5) one pig outputs 92.4 kg meat following (Gocsik et al., 2015); (6) the rotation speed of organic pig places in the Netherlands during the model run is 2.82 following (Gocsik et al., 2015) (7) in

2000 there were 9302 organic pig places in the Netherlands (own calculation following Hoste, 2005). This means that in 2000 there were 0.26 * 9302 = 2393 organic pig places, 2393 * 2.82 = 6748.26 organic pigs were slaughtered, and 6748.26 * 92.4 = 623539.22 kg of organic pig meat was produced in North Brabant; and (8) all organic meat produced in North Brabant in 2000 could be sold for organic price. Based on these assumptions, the demand function can be derived by plugging-in the values for 2000:

$$P_{org} = a * \frac{Q_{org}^{\ 1/\epsilon}}{T_{org}^{\ t}} \tag{12}$$

$$2.54 = a * \frac{623539.22^{\ 1/-1.13}}{1.05^{\ 0}} \tag{13}$$

$$a = \frac{2.54}{623539.22^{\ 1/-1.13}} = 341217.85 \tag{14}$$

The demand function for organic meat is:

$$P_{org} = 341217.85 * \frac{Q_{org}^{\ 1/-1.13}}{1.05^{t}} \tag{15}$$

APPENDIX 4.D. RESULTS EXPLORATORY ANALYSIS – EFFECT OF SOCIAL INFLUENCE PARAMETERS ON SIZE ORGANIC MARKET (EXCL. OUTLIERS)

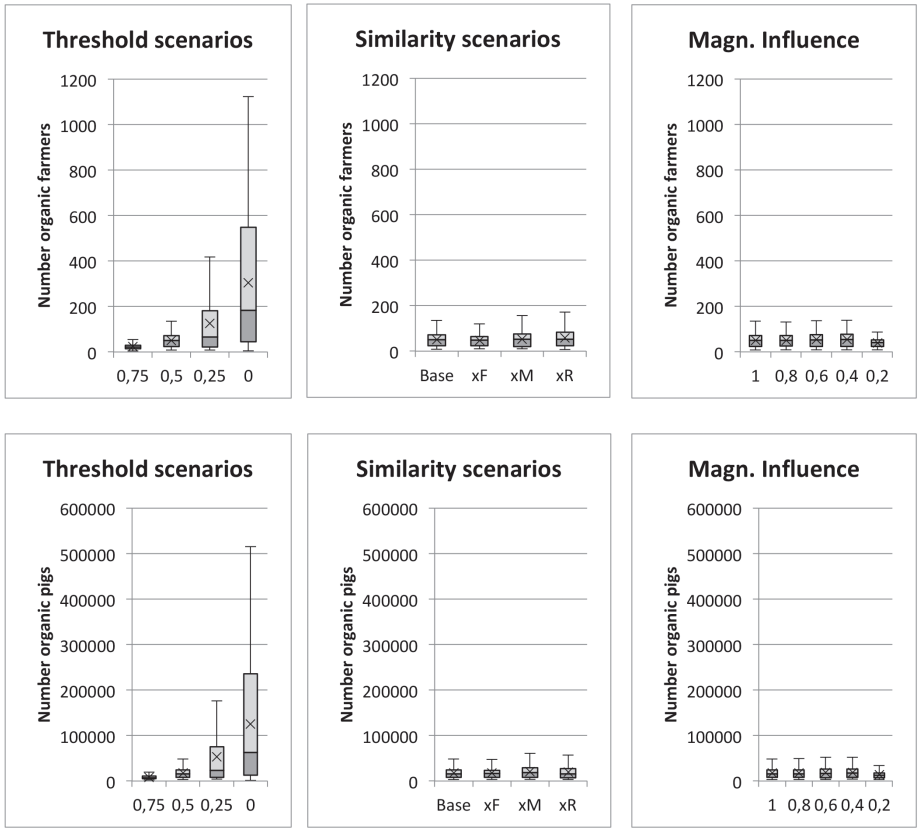

FIGURE 4.2. Results of exploratory analysis: effect of social influence parameters on size organic market (number organic farmers and number organic pigs)

APPENDIX 4.E. RESULTS EXPLORATORY ANALYSIS - EFFECT OF SOCIAL INFLUENCE PARAMETERS ON DIVERSITY OF FARMING STYLES (EXCL. OUTLIERS)

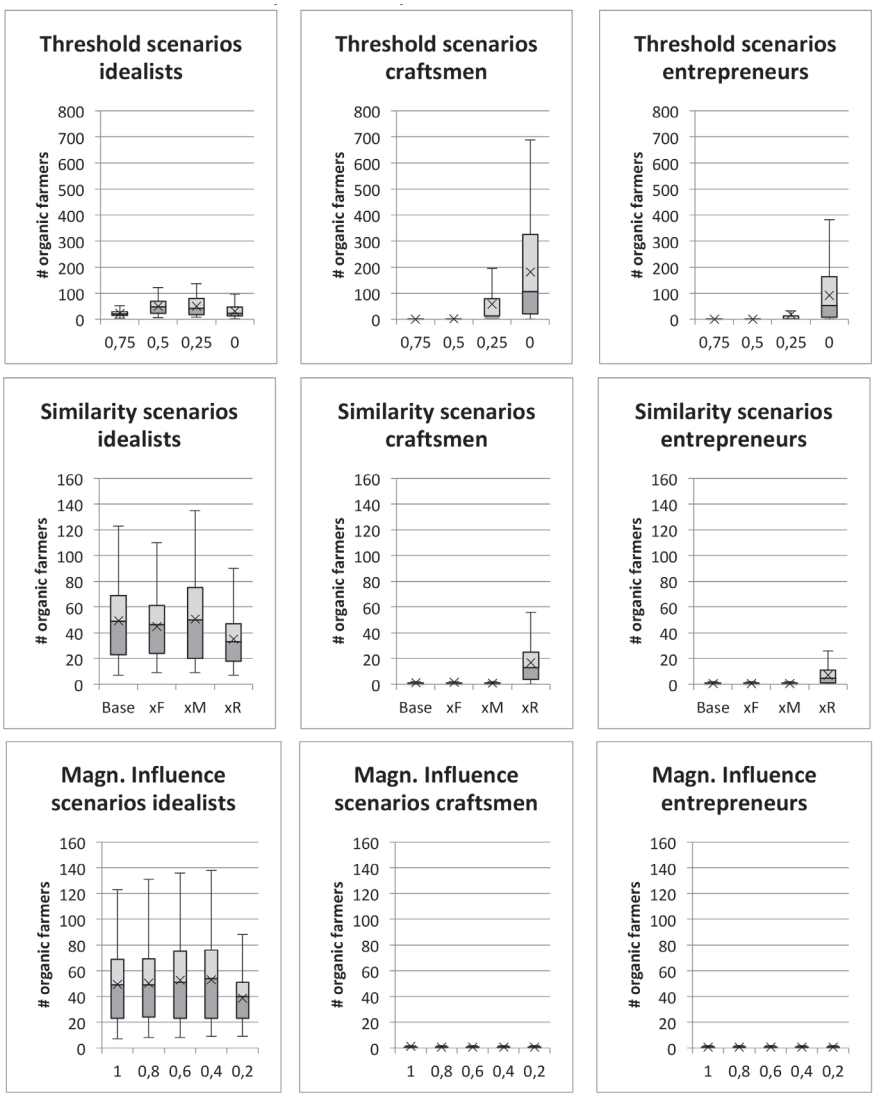

FIGURE 4.3. Results of exploratory analysis: effect of social influence parameters on diversity of organic farmers' farming styles (number of organic idealists, organic craftsmen and organic entrepreneurs)

TABLE 4.10. Scaled sensitivity of the model outputs to the model parameters and their rankings. Outputs are Number organic farmers and Number organic pigs.

Parameter name in model	Sensitivity of output to parameter [a]												Sum rank of parameters	Rank most influential parameter
	Number organic farmers						Number organic pigs							
	Low threshold scenario		Base scenario		High threshold		Low threshold		Base scenario		High threshold			
	SS[b]	R[c]	SS	R	SS	R	SS	R	SS	R	SS	R		
Elasticity of demand for organic pork	0.43	5	0.95	1	-0.60	5	0.81	2	1.15	1	-0.66	5	19	1
Chance successor same farming style	-0.46	4	-0.58	2	-0.29	10	-0.52	4	-0.65	2	-0.20	11	33	3
Fraction successor's attitude peers	0.49	2	-0.41	3	1.66	3	0.53	3	-0.48	6	1.76	4	21	2
% of farmers that receive news	0.71	1	-0.39	4	0.17	12	0.88	1	-0.50	5	0.20	12	35	5
Trend in demand for organic meat	0.18	10	0.29	5	0.45	6	0.19	10	0.31	7	0.48	6	44	7
Max attitude update based on income	0.02	18	-0.23	6	-0.09	13	0.03	18	-0.27	9	-0.07	15	79	12
Threshold credibility	-0.13	11	-0.20	7	-3.33	1	-0.12	13	-0.56	4	-2.74	1	37	6
Magnitude of influence	0.38	7	-0.18	8	0.40	8	0.27	9	-0.18	10	0.37	7	49	8
Chance farm. collects infodesiredmarket	-0.11	12	0.13	9	-0.04	15	-0.08	15	0.14	12	-0.13	14	77	11
Chance info seek beh same/innovative	0.07	14	-0.12	10	-0.02	16	0.10	14	-0.05	16	-0.02	16	86	14
Threshold attitude for investment	-0.37	8	-0.11	11	-1.24	4	-0.48	6	-0.62	3	-2.74	2	34	4
Threshold lack of credibility	0.46	3	0.09	12	2.10	2	0.50	5	0.29	8	2.26	3	33	3
# years for stable to be depreciated	-0.06	15	0.06	13	0.36	9	-0.14	12	-0.10	14	0.26	9	72	10
Income scaling factor	-0.41	6	0.04	14	0.01	17	-0.47	7	0.15	11	0.01	17	72	10
Weight market	-0.33	9	-0.03	15	-0.42	7	-0.33	8	-0.09	15	-0.31	8	62	9
Weight reference group	-0.02	17	0.03	16	0.20	11	0.06	16	0.13	13	0.16	13	86	14
Chance other market is in news	-0.04	16	0.02	17	-0.01	18	-0.04	17	0.03	18	0.01	18	104	15
Weight farm size	-0.09	13	0.01	18	-0.06	14	-0.17	11	-0.05	17	-0.22	10	83	13
#peers successor bases attitude	-0.01	19	0.01	19	0.00	19	-0.01	19	0.02	19	0.01	19	114	16

[a] *Sensitivity of the output to a small change in parameter*
[b] *SS = scaled sensitivity value*
[c] *R = rank of the influence of the parameter on the output (where 1 = most sensitive)*

TABLE 4.11. Scaled sensitivity of the model outputs to the model parameters and their rankings. Outputs are idealists craftsmen and entrepreneurs in organic.

Parameter name in model	Sensitivity of output to parameter [a]																		Sum rank of parameters	Rank most influential parameter
	Idealists in organic						Craftsmen in organic						Entrepreneurs in organic							
	Low threshold		Base		High threshold		Low threshold		Base		High threshold		Low threshold		Base		High threshold			
	SS[b]	R[c]	SS	R	SS	R	SS	R	SS	R	SS	R	SS	R	SS	R	SS	R		
Elasticity of demand for organic pork	0.52	1	0.39	2	-0.61	5	1.43	3	25.74	1	0.74	4	-6.93	1	1.74	2	-1.48	1	20	1
Chance successor same farming style	-0.52	2	-0.57	1	-0.28	10	-0.04	18	-1.26	8	-0.37	8	-1.72	8	-0.38	8	-1.11	2	65	6
Fraction successor's attitude peers	0.27	5	-0.27	6	1.72	3	0.67	8	-5.67	3	-0.06	16	3.07	3	-1.37	3	-0.68	7	54	4
% of farmers that receive news	0.28	4	-0.37	3	0.18	12	1.32	4	-1.83	7	-0.26	11	4.34	2	0.12	15	-0.14	15	73	7
Trend in demand for organic meat	0.16	9	0.31	4	0.45	6	0.15	13	-0.56	12	0.33	9	0.75	13	0.02	17	0.77	6	89	10
Max attitude update based on income	-0.09	11	-0.24	7	-0.08	13	0.32	11	0.33	15	-0.31	10	0.15	19	0.04	16	-0.14	14	116	16
Threshold credibility	0.06	13	-0.15	8	-3.38	1	-0.54	9	-3.03	5	-2.58	1	-1.06	10	-1.01	5	-0.18	11	63	5
Magnitude of influence	0.30	3	-0.27	5	0.40	8	0.91	6	5.41	4	0.06	15	-1.04	11	0.00	19	0.65	9	80	8
Chance farm. collects infodesiredmarket	-0.18	8	0.13	9	-0.02	15	0.01	19	0.35	14	-0.91	2	0.30	16	-0.27	9	-0.67	8	100	11
Chance info seek beh same/innovative	-0.07	12	-0.11	10	-0.01	17	0.33	10	-0.25	16	-0.81	3	0.87	12	-0.24	11	-0.17	12	103	12
Threshold attitude for investment	0.21	6	-0.11	11	-1.28	4	-1.80	2	-1.05	10	-0.49	5	-2.55	4	1.13	4	0.86	4	50	2
Threshold lack of credibility	-0.18	7	-0.10	12	2.14	2	2.24	1	7.50	2	0.12	14	1.52	9	1.79	1	0.78	5	53	3
# years for stable to be depreciated	0.01	19	0.07	13	0.36	9	0.04	17	0.05	17	0.38	7	-1.87	7	-0.65	6	0.00	19	114	15
Income scaling factor	-0.14	10	-0.02	18	0.00	18	-1.01	5	2.73	6	-0.22	12	-2.03	6	0.25	10	1.04	3	88	9
Weight market	-0.05	15	-0.04	16	-0.42	7	-0.90	7	0.02	19	-0.02	18	-2.24	5	0.17	13	-0.56	10	110	13
Weight reference group	-0.02	17	0.05	14	0.20	11	-0.18	12	-0.74	11	0.39	6	0.72	15	-0.21	12	0.16	13	111	14
Chance other market is in news	-0.02	16	0.03	17	-0.01	16	-0.07	14	-0.45	13	-0.05	17	-0.24	17	0.13	14	-0.01	18	142	18
Weight farm size	-0.06	14	0.05	15	-0.06	14	-0.06	16	-1.12	9	0.00	19	-0.73	14	-0.56	7	0.12	16	124	17
#peers successor bases attitude	0.02	18	0.01	19	0.00	19	-0.06	15	0.04	18	-0.21	13	-0.15	18	0.02	18	0.03	17	155	19

[a] *Sensitivity of the output to a small change in parameter*
[b] *SS = scaled sensitivity value*
[c] *R = rank of the influence of the parameter on the output (where 1 = most sensitive)*

APPENDIX 4.G. EXPERT INTERVIEW SETUP

4.G.1 GOAL

Goal: Validate selected model results by interviewing experts in the Dutch pig sector

4.G.2 RESULTS SELECTED FOR VALIDATION

Results that I want to discuss and relate to organic market conversion in the pig sector over the past 20 years (from 2000 till now):

1. Price elasticity of demand of organic meat by consumers and the diversity of farming styles of new entrants (i.e. new farmers in the pig farmer population) compared to their predecessor (i.e. the farmer who ran the farm before the successor took over) in the pork sector are the two most influential factors on the number of organic farmers and organic pigs.
2. Social interactions among pig farmers determine whether a price elastic or a price inelastic organic meat price is favourable for the increase of organic pig farmers. If the social interaction dynamics are such that converted organic farmers deliver more organic meat than the regular annual increase in demand for organic meat, a price *inelastic* price increases the size of the organic market, while a price *elastic* price negatively affects the size of the organic market.
3. Taking out polarisation among pig farmers between conventional and organic farming leads to more diversity in farming styles among organic farmers, yet not affecting the number of organic farmers and pigs. While it hardly affects the distribution of farming styles among conventional farmers.
4. The number of organic farmers and pigs is most sensitive to the successor parameters: the higher the probability of a farmer following a different farming style then the predecessor, the higher the number of organic farmers and pigs; and
5. The peers (farmers with the same farming style) of the successor determine whether the successor is more or less in favour of organic farming.

4.G.3 THE THREE SELECTED EXPERTS

1. Economic pork sector expert, working at Wageningen Economic Research
2. Farm manager for Dutch organic slaughterhouse
3. Feed advisor for an organic feed company

4.G.4 INFORMATION FOR EXPERTS THAT I PRESENT AT THE START OF THE INTERVIEW

For my research I built a model on organic market conversion in the Dutch pig sector. In this model I modelled pig farmers in the province of Noord-Brabant and I initialised the model with data of 2000, among others assuming that 16 out of 1964 pig farmers were organic in 2000 in Noord-Brabant. Two points of focus in this research were social interaction, which affects the decision to convert, and organic price dynamics through supply and demand. The model ran for 15 years, and the output of the model is the number of organic farmers and organic pigs, and the types of farmers (i.e. idealists, craftsmen and entrepreneurs) producing for the organic market. The purpose of the model is to gain insight in the most important mechanisms for organic market conversion.

What I want to do in this interview is to discuss the results of the model and how you think this relates to the real-world mechanisms, i.e. organic market conversion among pig farmers from 2000 till 2015. First I'll show you the category of factors that are considered in the model and might influence the conversion decision of farmers.

4.G.5 CATEGORY OF FACTORS THAT INFLUENCE CONVERSION DECISION

1. Social influence factors (basis: when a farmer is deemed credible, that farmer can influence other farmers in terms of their perception towards organic pig production. The degree of influence depends on a number of parameters, namely):
    a. Similarity between farmers in interaction (i.e. farm size, farmer type, and market: organic or conventional) increases the credibility of the other farmer, while dissimilarity decreases the credibility of the other farmer.
    b. The innovative/conservative parameter: Innovative farmers determine the other farmers' credibility on the status of the other farmer, while conservative (conformist) farmers determine the other farmers' credibility on the similarity between them.

c. The credibility threshold for influence: The level of credibility of the other farmer that should exceed the (predefined) influence-threshold in order to influence the attitude of the farmer towards organic farming.

2. Market factors:
   a. Annual increase in demand
   b. Price elasticity of demand, i.e., how sensitive (=elastic) the demand for organic meat is to a small change in market price of organic meat
3. Successor factors:
   a. Income predecessor
   b. Chance of having a successor
   c. The chance the farming style of the successor is the same farming style as his/her predecessor
   d. The attitude of the successors peers, i.e. the farmers within his/her network that have the same farming style, towards organic
4. News factors:
   a. The percentage of farmers of all modelled farmers that is subscribed to pig news magazines
   b. The percentage of pig news magazines that have an interview with a farmer of an opposing market (i.e. when the conventional farmer reads about organic farmers and the other way around)
5. Information searching behaviour on technical performance in alternative market:
   a. How often farmers search for technical production information about the other market once they are interested.

4.G.6 QUESTION 1-3 – MOST INFLUENTIAL FACTORS ON SIZE OF ORGANIC MARKET

1. *I would like you to think of the three most important factors that influence the size of the organic market according to your experience and knowledge of the field. Could you explain to me why you think this is so?*

The results of my research shows that price elasticity AND new entrants through successors are the most influential factors on the number of organic farmers and pigs.

2. *Are you surprised with these results?*
3. *(If they differ according to the expert's expectations). Why did you think these parameters were (not) influential? And do you have any evidence or experience related to your expectations?*

4.G.7 QUESTION 4-8 – ELASTICITY OF DEMAND

4. *Do you think demand for organic meat is rather elastic or inelastic, compared to conventional meat? (after explaining the difference)*
5. *What do you think is more favourable for the size of the organic market: an elastic demand or inelastic demand of organic meat? Why do you think so? And is this always the case?*
6. *Do you think whether the elasticity of demand can be influenced? Who or what could influence this? And How?*
7. *And do you think the elasticity of demand is stable over time?*

The results of our model show that social influence dynamics determine whether or not a price elastic or a price inelastic organic price is favourable for the size of the organic market. This works as follows in the model:

Scenarios

Increase in demand for organic meat versus potential increase in supply of organic meat	*A low or high price elasticity*	*Effect on organic price*	*Effect on number of organic farmers and pigs*
increase in demand > increase in supply	Low price elasticity	Small increase in price	Negative effect on number of organic farmers and pigs
	High price elasticity	Steep increase in price	Positive effect on number of organic farmers and pigs
increase in demand < increase in supply	Low price elasticity	Small decrease in price	Positive effect on number of organic farmers and pigs
	High price elasticity	Steep decrease in price	Negative effect on number of organic farmers and pigs

8. *Looking back at how the organic market developed, can you relate these results to organic market development over the past years. Do you think a high price elasticity was favourable for more farmers to be interested, or do you think that a price inelasticity is favourable for the increase of the organic market. Or has it been a combination of both?*

4.G.8 QUESTION 9-14 DIVERSITY OF FARMER TYPES IN ORGANIC & THE SIZE OF THE ORGANIC MARKET

We distinguished three different (ideal) types of farmers in the model:

- The entrepreneurs, who focusses on profit maximisation through scale enlargement and management, which combines labour efficiency, reducing costs, and increasing production efficiency
- The craftsmen, who also focuses on profit but through technical efficiency: high piglet production, better feed conversion.
- The idealist, who focuses on the intrinsic needs of the animal, does not opt for increasing profits.

9. *Do you recognise the diversity in farming types?*
10. *Would you say that at the start of the organic market, there was a diversity in farmer types (i.e. their definition of good farming practices), or that most farmers were similar?*
11. *How were the farmers different or similar?*
12. *Did this change over the past 20 years?*

One of the results in my model was that if the 'idealistic' reputation of the organic market is not modelled, i.e. when there is no polarisation between idealist farmers and craftsmen or entrepreneurial farmers, more types of farmers enter the organic market.

13. *Do you recognise this?*

Related to this result is that an increase in the diversity of different types of farmers in the organic market does not lead to an increase in the size of the organic market (under average threshold for social influence).

14. *Is this according to your expectations?*

4.G.9 QUESTIONS 15- END OF THE INTERVIEW

15. *Did the results of the model give new insights?*
16. *Do you have any other comments or questions?*
17. *Would you like me to send the minutes of the interview?*
18. *Would you like to receive the article when it is published?*


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CHAPTER 5

GENERAL DISCUSSION

In this research, the diffusion of added-value markets in the Dutch pork sector was studied from a Complex Adaptive System's perspective (CAS). A CAS perspective means that added-value market diffusion is understood as an emergent outcome of interactions between system actors (e.g., farmers) and system components (e.g., farm resources and market prices). Three main research questions were asked to gain insight into the diffusion of added-value markets in the Dutch pork sector. 1. "Which factors influence pig farmer decision-making across time?". 2. "To what extent does social interaction affect the diffusion of investment strategies?". 3. "How do interaction and context influence the diffusion of organic farming?". This chapter presents the responses to these questions, discusses the usefulness of the CAS approach as well as the methodologies applied in this research. Thereafter follows a deliberation of the implications, and recommendations for policy and future research. The chapter closes with a brief overview of the main conclusions.

5.1 MAIN FINDINGS

5.1.1 WHAT FACTORS INFLUENCE PIG FARMER DECISION-MAKING IN A TIME-DEPENDENT CONTEXT?

Current literature points to many factors that influence pig farmer decision-making behaviour. These can be grouped into personal, social and contextual factors (Chapter 2). This categorisation was inspired by the reasoned action approach (Ajzen, 2012; Fishbein & Ajzen, 2010), and represents the attitude (personal), subjective norm (social), and perceived behavioural control (contextual). Many studies use the reasoned action approach as a framework to measure behaviour at one point in time (Bechini et al., 2015; Rose, Keating, & Morris, 2018; Sok, Hogeveen, Elbers, & Oude Lansink, 2015). This study differs in this respect as it used the framework as an inspiration to position the farmer in a time-dependent dynamic context. For this purpose, it is important to consider the individual farmer in his/her social environment, and to allow for reference group related influence (Chapter 2). This builds on previous research that associated normative influence with specific reference groups (see for examples Beedell & Rehman, 2000; de Lauwere et al., 2012; de Rooij et al., 2010). In addition, it takes account studies that relate farmers' resistance to change to their dominant self-concept and related 'good farming

practices' (Burton & Wilson, 2006), and it demonstrates the social pressure that farmers experience when moving away from peer groups' notions of good farming practices (Chapter 2, Alexopoulos et al., 2010; Lamine & Bellon, 2009).

Moreover, since people and their contexts can change, it proves to be important to (1) distinguish between static and dynamic factors of decision-making (Chapter 2 and 4), (2) to identify factors that contribute to dynamics (Chapter 2, 3, and 4), and (3) to appoint potential feedback mechanisms (Chapter 2, 3, and 4). Together they place the farmer within a changing environment, and move from static observations of farmer decision-making, to a focus on decision-making dynamics. Other researchers working on complex adaptive systems in the agricultural sector (Feola & Binder, 2010) have underlined the importance of feedback mechanisms too, but feedback mechanisms are not taken into account by snapshot studies of farmer decision-making behaviour (see for examples Aubert et al., 2012; Hyland et al., 2018; Kemp et al., 2014; Mills et al., 2018; Tepic et al., 2012). For snapshot studies of farmer decision-making it is sufficient to 'just' identify and measure the factors that contribute to decision-making, without considering their change over time and what causes this change. Time dependency, therefore, requires a fundamentally different approach to farmer decision-making behaviour.

As opposed to a static attitude as measured within the reasoned action approach (Fishbein & Ajzen, 2010), attitudes are assumed to change as a consequence of a static personality factor (innovativeness vs conformist) and dynamic reference group related social influence (Chapter 4), following empirical evidence on changes in farmer attitudes (Helitzer, Hathorn, Benally, & Ortega, 2014) and theoretical notes on the attitude concept (Bergman, 1998; Petty & Wegener, 1998). Four social factors were identified that contribute to change and persistence in farmers decision-making behaviour through their social environment: reference groups' norms (Chapter 2), opinion leaders (Chapter 3), status symbols (Chapter 4), and similarity in farm(er) characteristics (Chapter 2 and 4). These are well-known social influence mechanisms in social-psychological theory (Brown, 2000b; Cialdini & Goldstein, 2004; Festinger, 1954; Hornsey, 2008; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008; Rogers, 2003). Apart from the farmers' social environment, we found that the contextual environment restricts farmers' decisions: current farm resources, their investment rhythm, market size given by perceived consumer demand, trust in markets and policies, and the possibility for bank loans and permits (Chapter 2). These factors change over time due to depreciation

of stables, market price dynamics (Chapter 2, 3 and 4), and policies (Chapter 2). This is in line with previous research on pig farmer decision-making, which found that farmers' opportunities to invest in alternative stables are limited by their investment rhythm (Gocsik et al., 2015; Oude Lansink et al., 2003) and that certainty of price premiums is important in conversion decisions (Chapter 2, Gocsik et al., 2015).

5.1.2 TO WHAT EXTENT DOES SOCIAL INTERACTION AFFECT THE DIFFUSION OF INVESTMENT STRATEGIES?

This thesis showed that the extent to which social interactions between farmers can influence diffusion of investment strategies and/or added-value markets, is dependent on the perceived relative economic advantage of the alternative investment strategy (Chapter 2, Chapter 3 and Chapter 4), on communication (Chapter 3), and on the presence of an opinion leader (Chapter 3). The perceived relative economic advantage of an alternative farming strategy serves as a mediating factor for diffusion (Chapter 3 and Chapter 4), and is dependent on a complex interplay between social interaction dynamics among farmers on the one hand (Chapter 3 and 4), and supply chain regulations and consumer demand on the other hand (Chapter 4).

5.1.2.1 MARKET REGULATION

In an unregulated market - i.e. supply and demand is not regulated by supply-chain actors through waiting lists or fixed consumer prices - the dynamics of social interaction among farmers can influence excess supply, mediated by the price elasticity of demand (Chapter 4). In a regulated market, social interaction can cause excess demand, but excess supply is prevented by a waiting list (Chapter 2 and 4). In this situation, consumer demand, given a waiting list and a stable consumer price, limits diffusion of added-value markets (Chapter 4). This confirms previous research which found that the limits to growth in organic farming lies in demand (Kaufmann, Stagl, & Franks, 2009; Smith & Marsden, 2004), structural financial policies that support alternatives (Kaufmann et al., 2009), and/or supply chain relations that influence the profitability of organic farming (Smith & Marsden, 2004).

5.1.2.2 STUDY SCOPE

At the same time, this thesis goes further than previous diffusion studies that focus solely

on the role of social interactions in diffusion (Olabisi, Wang, & Ligmann-Zielinska, 2015; Xu, Huet, Poix, Boisdon, & Deffuant, 2018). Our findings show that it is important to take a wider scope than just the farmer population, even when allowing for social influence by farmers' social environment (Chapter 4). Especially in the case of excess supply in added-value markets or in the presence of waiting lists for farmers to convert, the scope of research should include supply-chain actors, their interactions, and consumer demand dynamics. This supports the argument made by Rose et al. (2018) that it is important to go beyond the individual farmer who is often regarded as the sole decision-maker who needs to be convinced of a better alternative. We take this a step further and argue that the same holds for the farmer population in general when considering diffusion of added value markets.

5.1.2.3 SUCCESSORS

In addition, this research points at the important role for successors in the diffusion of added-value markets. Chapter 4 showed that new entrants change the Dutch pork sector. First of all, the availability of a successor, and the transition of the farm to a successor, can be a trigger for considering alternative investment strategies, such as the conversion to an added-value market. This confirms previous research by Sutherland et al. (2012). Secondly, the absence of a successor can limit current farmers' investment rhythm when they are approaching retirement age, and can limit their opportunity to convert (Kemp et al., 2014; Oude Lansink et al., 2003). Third, this shows that the current pig farmer population can be rather conservative, because successors bring about change. They do so by diversifying the current farming styles in the farmer population, and through different peers (Chapter 4). Current farmers seldom change farming styles and have, therefore, a relatively static dominant reference group. The social environment, hence, hardly changes which explains why new entrants can have such an important role in the diffusion of added-value markets. This is supported by Chapter 2 and previous research, which found that farmers experience social pressure when they consider alternative investment strategies (Chapter 2; Alexopoulos et al., 2010; Lamine & Bellon, 2009). This also supports the findings by Xu et al. (2018) which demonstrate that one of the reasons that farmers do not convert is because of negative evaluations of organic farming by "important others". It furthermore shows that the findings by Burton (2004) can still be relevant for the Dutch pig farming context: farmers are reluctant to let go of their dominant productivist self-

concept. So, the finding that new entrants can bring about change in the Dutch pork sector, confirms previous research results on conservative social peer pressure among farmers.

5.1.3 HOW DOES INTERACTION AND CONTEXT INFLUENCE DIFFUSION OF ADDED-VALUE MARKETS?

This thesis used the social identity approach to operationalise mechanisms of how interaction between farmers leads to behaviour change (Chapter 2 and 4). This includes assumptions on the driving force behind human decision-making, and factors that contribute to such a change (see discussion above).

5.1.3.1 GROUP MEMBERSHIP

According to the social identity approach, the driving force of human behaviour is group membership (Chapter 4). In this thesis, farmers' difference in group membership partly defined farmer heterogeneity (Chapter 2 and Chapter 4). This is complementary to empirical studies that identified farmer heterogeneity in their definition of 'being a good farmer' (Burton, 2004; Commandeur, 2006; de Rooij et al., 2010; van der Ploeg, 1994, 2010; Vanclay, Howden, Mesiti, & Glyde, 2006; Vanclay & Silvasti, 2009), and to studies that identified group related social influence (Beedell & Rehman, 1999; de Lauwere et al., 2012). The approach taken here is in contrast with studies that used the underlying assumption of rational economic farmers who strive for profit optimization, such as the studies by Schouten et al. (2012) and Schreinemachers & Berger (2011). The social identity approach is more comprehensive than traditional assumptions on rational economic behaviour. It encompasses those individuals that do strive for profit optimization as a special case, while accounting for farmers who make choices based on lifestyle concerns (Commandeur, 2006; de Rooij et al., 2010). According to the social identity approach, both types of farmers act out of group membership motivations: even a profit maximiser does so for social reasons. The social identity approach is, therefore, able to combine empirical findings that appoint profit maximization as the most important factor for adoption decisions of sustainable practices (Mandryk, Reidsma, Kanellopoulos, Groot, & van Ittersum, 2014) with studies that found that farmers are also lead by environmental motivations to adopt, e.g., more sustainable stables (Kemp et al., 2014).

5.1.3.2 EXPLANATION FOR UNCONSCIOUS DECISIONS

Besides, the theory provides an explanation for economically irrational and unconscious decision-making processes. The latter is relevant in the human context, in which humans are known to rationalise their decisions after they have been made, while being unconscious of the stimuli that led to their decisions (Nisbett et al., 1977; Nolan et al., 2008). The human tendency to reproduce results of their thinking instead of the cognitive processes that lead to these results (Nisbett et al., 1977), makes it hard to derive some of the underlying motivations of decisions in traditional snapshot studies of farmer decision-making, as these studies have mostly been done after conversion (Lamine & Bellon, 2009). The social identity approach provides an interesting underlying explanation for normative social influence to occur. This thesis showed that this type of social interaction can restrict diffusion of added-value markets, since new entrants can bring about more change in the Dutch pork sector than social interactions between current farmers can (Chapter 4 and see discussion above).

5.1.3.3 MULTIPLE REFERENCE GROUPS

Finally, the social identity approach provided a solid basis on which to improve the mechanism of how social influence can contribute to behaviour change (Chapter 4). It can also help to understand differences in farming styles between successors and their predecessors according to differences in reference groups (Chapter 4). Chapter 4 accounted for one dominant farming style reference group that guides the farmers' behaviour through status symbols. This mechanism can be refined, in line with the social identity approach, by accounting for multiple farming styles reference groups and a civic reference group (Chapter 4). The existence of multiple reference groups builds on current empirical knowledge, including a civic reference group that explain why farmers react to changes within society (Bock, Swagemakers, Jacobsen, & Ferrari, 2010; de Rooij et al., 2010; Schreiner & Hess, 2017). Future research can, therefore, build on the mechanism developed in this thesis by accounting for multiple farming style reference groups and potential changes in status symbols within a reference group.

5.1.3.4 MARKET PRICE DYNAMICS

Finally, this thesis looked into farmer interactions with market price dynamics. In an unregulated market and in case of excess demand, a high price elasticity of demand for

organic meat is favourable for diffusion (Chapter 4); it causes a steep increase in farm gate price, which increases the satisfaction of current organic farmers who can trigger other farmers to convert. In an unregulated market and in case of oversupply, a low price elasticity of demand for organic meat is favourable for diffusion, because excess supply hardly affects a decrease in farm gate price. In that case additional farmers can still enter without affecting the profitability of an added-value market strategy much. This mechanism is able to explain the interplay between excess supply and the perceived economic advantage of added-value markets as witnessed in the past in the organic pork sector (Chapter 2; Biologica, 2003). This thesis contributes to previous studies that found an important role for the perceived economic advantage of an investment strategy in conversion decisions (Bartkowski & Bartke, 2018; Brudermann et al., 2013; Mandryk et al., 2014), by placing the perceived economic advantage in a dynamic context. The proposed mechanism, however, is too simple for understanding farm gate price dynamics in a regulated market, such as is the case in the Dutch organic pork sector. To gain a better understanding of how excess supply affects farm gate prices in a regulated market setting where consumer prices are kept stable, additional research in supply chain relations, regulation and power among supply chain actors is required. Lastly, context influences the diffusion of added-value markets through the availability of successors, the farming style of the successor, and the peers of the successor as described above.

5.2 METHODOLOGY AND THEORY

As can be seen above, a complex adaptive system (CAS) approach searches to understand how and why local interaction between system actors and components lead to behavioural change and diffusion of added-value markets. This thesis used a combination of research methods to gain insight in the effect of interaction on diffusion. Below I will evaluate these methods. Agent-based modelling is discussed in a separate chapter.

I used a combination of behavioural theory (the reasoned action approach), social theory (social identity approach), empirical research on farmer behaviour, and case-specific (semi-structured) interviews to conceptualise pig farmer decision-making from a CAS perspective, as outlined above (Chapter 2). The reasoned action approach was able to integrate factors that influence decision-making. However, it does not distinguish

between static and dynamic factors (Fishbein & Ajzen, 2010) and fails to provide feedback mechanisms of how social structures influence farmer decision-making behaviour. The social identity approach (Brown, 2000a; Hornsey, 2008), on the other hand, offered a theory on how and why interaction can influence behaviour change. This enabled the identification of mechanisms and factors that cause dynamics. It provided feedback mechanisms on a conceptual level between social structures (group level status symbols, norms and opinion leaders) and farmer decision-making behaviour through reference group related influence. It was, hence, helpful to combine both theories. Empirical research on factors that influence farmer behaviour and interviews with pig farmers specified relevant antecedents on behaviour in a pig farmer context. Semi-structured interviews appointed the contextual factors that influence farmers' perceived space to manoeuvre. This is necessary for all applied studies on investment diffusion.

Simulation games offered an experimental setting to study the extent to which social influence can influence added-value market diffusion in a situation where farmers are restricted by contextual factors, such as their farm resources, volatile market prices, bank loans and the demand for alternative produce to conventional produce (Chapter 3). Farmers, or people in general, are often unaware of the role of social influence in their decision-making behaviour (Nisbett et al., 1977; Nolan et al., 2008). This makes it hard to study the effect of social influence on decision-making through interviews. An experimental setting that allows for communication and farmer decision-making behaviour over several rounds, offers more insight in the role of social interaction on diffusion. We were able to identify opinion leaders and track their influence on diffusion. In this thesis, the simulation game indeed triggered participants to think about their situation in the real-world, as has been shown in previous studies that used games (Anderies et al., 2011). It must be noted, however, that finding and motivating farmers to participate in a simulation game is challenging. Communication towards potential participants is delicate, especially when mentioning the word 'game', because farmers perceived a game to be unprofessional, not something to take serious, or something to do with farmer youth. Combining this with a 'workshop' could help and accentuate the added-value for farmers to participate.

5.3 AGENT-BASED MODELLING

A CAS framework of decision-making is useful for measuring behavioural antecedents of behaviour at one point in time, and to think about the possible feedback mechanisms between (social and farm resource) structures and farmer decision-making (Chapter 2, Feola & Binder, 2010). The agent-based modelling method goes one step further. It requires researchers to specify the cognitive mechanisms that lead to behavioural change and to operationalise them in detail. This is the major advantage of agent-based modelling: it demands precise mechanisms of why and how individuals are influenced in interaction, and therewith change macro-level patterns. At the same time, the required level of detail is its major challenge.

5.3.1 THEORETICAL SUFFICIENCY

The development of an agent-based model gives unlimited computational freedom and flexibility in the translation of a conceptual model of farmer decision-making (Sun et al., 2016). In this thesis we experienced that both behavioural theories, the reasoned action approach and social identity approach, were not suited for the required level of detail needed in formalising an agent-based model. The reasoned action approach is not designed for a dynamic environment, and does not account for steps taken in a decision-making process, whereas previous research indicate that decisions that have medium- to long-term consequences for farmers, are often preceded by so-called trigger events (Sutherland et al., 2012). Interviews can serve to identify important trigger events. Trigger events identified in this thesis, for example, were depreciation of current stables (Chapter 2), a financial offer for current farm buildings (Chapter 2), interaction with (slaughterhouse) advisors (Chapter 2), and/or farm succession (Chapter 4). The reasoned action approach in combination with the interviews, however, does not provide specific computational rules on the order of a decision-making process. Still, questions arise such as "Does a farmer first need to be interested in an alternative farming strategy (e.g. as a consequence of social interactions), before s/he considers the economic benefit?", "Does a farmer, before considering an alternative farming strategy, need to be dissatisfied with the current situation?", as is modelled by Xu et al. (2018), or "Is an opportunity to invest sufficient for considering alternatives?". Additional assumptions and researchers' creativity is, therefore, required.

5.3.2 EQUIVALENT COMPUTATIONAL IMPLEMENTATION OF SAME THEORY

The social identity approach fell short for application within an agent-based model too, although it provides knowledge on how and why individuals are influenced in interaction. Questions arise such as "Is one interaction with a different minded farmer enough to change attitudes?", "How much similarity factors do individuals have to have in common for influence to take place?", "When is a farmer negatively influenced by an outgroup individual?", or "Does a low status individual influence a high status individual?"; and if so "How much do the statuses need to differ for a low status farmer to be still influential on a high status farmer, and in what direction?", etc. This level of detail is not provided for by the social identity approach. Assumptions on social influence parameters in the model are, therefore, unavoidable. In other words, cognitive mechanisms of individual decision-making behaviour remain largely a black box, also with available behavioural theory and empirical data; nevertheless researchers need to identify these mechanisms precisely for an agent-based model. In addition, alternative computational implementations of the same behavioural assumptions can hardly be tested due to time-constraints (of sensitivity analysis), and due to researchers' cognitive limits in thinking up alternatives. For example, the argument for heterogeneous farmers and reference group related influence on organic farming conversion was also made by Xu et al. (2018). Their computational implementation, however, differed from the one in this research. It would require a new model with two alternative computational implementations of the same conceptual model, and one model goal, to be able to compare the two mechanisms. Without this comparison, it is hard to know whether the conceptual model or the computational implementation of the conceptual model generates model results. Also, as Gilbert (2008: p. 31) puts it, "one must guard against alternative explanations", meaning that other plausible agent behaviours could possibly generate the same outcome. This has also been addressed by Flache et al. (2017) who stated that to overcome these challenges it is important to be very transparent about the choice for a specific conceptual model, and to test different technical implementations of the same (social influence) assumptions (Flache et al., 2017), in so far as this is possible. This can be done for the most conceptually interesting mechanism(s) in a study. In this case, it could be done for reference group related influence through a combined effort of the researchers that came up with different implementations.

5.3.3 SIMPLICITY VERSUS COMPLICATEDNESS

Another point for the discussion above that needs attention and which is a long-standing discussion with (agent-based) models in general, is the delicate balance between simplicity and complicatedness (Janssen & Ostrom, 2006; Sun et al., 2016). Complicatedness refers to model structure, i.e., the number of micro-level behavioural rules for agents in the model (Sun et al., 2016). Whereas, complexity in a model refers to model behaviour, i.e., the result of interactions between many agents, which can cause non-linear (complex) macro-level patterns. The fact that the model in this research is applied to a specific case study makes it more complicated: there are more parameters needed that are only applicable to this case study than the number of parameters required in a generic model of added-value market diffusion. It is not a complicated (facsimile) model meant the reproduce a pattern as exactly as possible (Gilbert, 2008). Instead, this model has an intermediate level of complicatedness (O'Sullivan, Millington, Perry, & Wainwright, 2012; Sun et al., 2016). A relatively sophisticated mechanism for social influence was developed for the model, which was applied to a specific case study. This makes the social influence mechanism more realistic than generic mechanisms for social influence, and, hence, makes it more suitable for generalisations to, e.g., agricultural practitioners or policy-makers (Yilmaz, 2006). In this case, a thorough understanding of the case study helped to design mechanisms that influence farmers: a mechanism that explains how an added-value market can diffuse from one reference group to another. This would have been hard if the model had been meant to simulate diffusion of added-value markets in farmer populations in general. In other words, in the absence of a specific case, the social influence mechanism would probably have been more generic and simplistic, and probably, less useful for generalisations.

5.3.4 AGENT-BASED MODELS AS A TOOL FOR BOUNDARY-WORK

Finally, for agent-based models there remains a challenge to externally validate them (generalize conclusions from the model to the outside world) (Bruch & Atwell, 2015; Gilbert, 2008). Validation is challenging because (1) there is a general lack of social science data to specify social interaction mechanisms based on theory as described above; (2) agent-based models can produce non-linear results due to complex local interactions, which are often partly based on unknown values for parameters (Lux & Zwinkels, 2018); and (3) agent-based models might be able to reproduce patterns observed in the real

world, based on underlying behavioural mechanisms that are far from realistic. Given the challenge with validation of model structure and results, and the inherent flexibility and freedom in developing agent-based models as discussed above, the results of agent-based models are subject to a lot of uncertainty. Instead, the agent-based modelling process, not the results, fulfil an important role for researchers and policy-makers to understand the system and this is an ongoing process. In this thesis, agent-based modelling served to gain further insight in the required system boundary (here: include supply-chain actors and consumers), in cognitive mechanisms for influence (here: multiple reference groups including a civic reference group), in the role of different stakeholders in the system (here: e.g., new entrants play an important role on diffusion), and in combining knowledge from different scientific disciplines (here: social-psychology, farm business economics and sociology). The modelling cycle is an indispensable step for this boundary-work on systems. In this thesis, model results gained meaning when discussed with relevant experts, and discussion with experts pointed to directions for further improvement of model structure. Therefore, agent-based modelling, the process not the outputs, give insight in the system under study, including its mechanisms and the relevant actors and components that affect macro-level patterns. This is in line with researchers' previous experience with policy models: "designing and using the model (…) provides understanding of the policy domain, rather than the numbers it generates" (Gilbert, Ahrweiler, Barbrook-Johnson, Narasimhan, & Wilkinson, 2018).

5.4 GENERALISABILITY TO OTHER LIVESTOCK SECTORS

Since the social interaction mechanism is built on the social identity approach and on well-known social influence mechanisms (as discussed under 'main findings'), it is likely to be applicable to other livestock sectors, and in diffusion studies among humans in general. What needs to be contextualised for each case study, and for the behaviour in question, are the relevant reference groups for an individual and/or population based on relevant (contextual) similarity factors, and the status symbols of each reference group. Empirical research shows that dairy farmers employ similar farming styles as pig farmers (de Rooij et al., 2010). So far, little is known about farming styles among poultry farmers. However, research by Bock et al. (2007) showed that also poultry farmers differ in their

idea of 'good farming practices' regarding animal welfare which is one of the elements of farming styles (Commandeur, 2003; de Rooij et al., 2010).

There is also contextual similarity between the pig sector on the one hand, and the dairy and poultry sector on the other hand. Both poultry and dairy farmers produce for an increasingly competitive international market (Jongeneel & van Berkum, 2015), and have, predominantly, capital intensive production systems (Hendrickson & Miele, 2009). Added-value markets exist in both sectors to compensate for an increase in cost price due to measures or investments that decrease negative externalities of production. The required investment, however, is different per sector. For broiler farmers conversion to an added-value market concerns either an investment in building, inventory and land (i.e. niche), or an investment in inventory (i.e. intermediate) (Gocsik, Oude Lansink, & Saatkamp, 2013; Gocsik et al., 2015). This is similar to conversion requirements for pig farmers, except that pig farmers require less land for outdoor access. For dairy farmers conversion to an added-value market concerns mainly a change in managerial aspects (Berentsen, Kovacs, & van Asseldonk, 2012; Smit, Driessen, & Glasbergen, 2009). Another difference between pig and poultry on the one hand, and dairy on the other, is that new entrants in the dairy sector can theoretically include others than direct successors. According to Jongeneel & van Berkum (2015) arable farmers can theoretically also convert to dairy farming, because they own land.

Given that in both poultry and dairy, added-value markets exist to compensate for an increase in cost price, consumer demand is likely to play a similar important role in limiting diffusion. In addition, supply-chain relations and regulation are likely to play an important role in relation to social interaction dynamics among farmers when determining the profitability of alternative farming strategies, and, therewith, its diffusion. Finally, the question remains to what extent new entrants bring about change in the dairy and poultry farmer population. This depends on whether added-value markets that decrease negative externalities of production are already a norm in the farmer population, and whether new entrants can diversify farming styles and reference groups within the farmer population. In other words, it depends on the norms of the current dominant farming styles, and on the distribution of farming styles in the farmer population. For all sectors, young successors are likely to add variety in farming styles and reference groups, because they are more likely to have different peers than their predecessors. This might not directly stimulate diffusion of current added-value markets, since this is dependent on

the dominant norms in the sector, but it is likely to stimulate development of alternative farming strategies in general.

Finally, the results of this thesis are partly based on a farmer population that consists of a minority of idealists, a majority of craftsmen, and an intermediate group of entrepreneurs. In addition, initial organic farmers were assumed to be idealists and farmers' network formed predominantly with farmers who produce for the same market (Chapter 4). No research was done on the effect of a different population and/or network instantiation. This means that the results of this research are applicable to other cases only in so far that a similar initial situation applies. For the Dutch dairy and poultry sector this is likely to be the case, given the (likely) similarity in farming styles as described above. For livestock sectors outside the Netherlands, additional research is required. Also, in this research variables that affect the actual behavioural control of farmers were not taken into account for diffusion (i.e. access to bank loans and required permits). Added-value markets that do not require any of these are more likely to diffuse, since a strong intrinsic motivation is less important (Chapter 4).

5.5 IMPLICATIONS

5.5.1 AGRICULTURAL PRACTITIONERS

Agricultural practitioners who work with farmers and try to stimulate alternative farming strategies, can be inspired by the social influence mechanism developed in Chapter 4. Given that similarity in person and context, status, and openness to new experiences play a role in influence, practitioners can take these factors into account. This means that practitioners can, for example, accentuate similarities between farmers in meetings (e.g. similarities in age, gender, farm size, 'good farming practices', status). Or they can arrange meetings between farmers with an alternative farming practice, and farmers who are open to new ideas. It is important to think about status symbols in the alternative farming strategy that are relevant for farmers: e.g. an entrepreneurial farmer might be less interested in pigs' intrinsic needs but more in the viability of an added-value market. In other words, practitioners can think in terms of status symbols, personality and similarity to stimulate diffusion.

5.5.2 POLICY IMPLICATIONS

If the intention of policy-makers is to decrease the negative externalities of pork production by means of added-value markets, a focus on consumer demand, and/or new entrants is likely to be most effective. When policy makers focus on consumer demand, the share of Dutch consumer demand within total Dutch pork production should be taken into account. Currently around one third of Dutch pork is consumed within the Netherlands, and 15-20% of Dutch pork production is produced under the 'one star better life' concept (Jukema, Ramaekers, & Berkhout, 2020). Diffusion by means of stimulating Dutch consumer demand, therefore, has its limits.

Policy makers have several policy options at their disposal to stimulate diffusion of added-value markets: legal instruments, financial instruments and communicative instruments (Allen & Hof, 2019; Stolze & Lampkin, 2009; Van Kooten, 2019). Since the 'one star better life' concept is only recognised within the Netherlands, legal instruments for labelling and certification within the EU ensures EU-wide recognition and can stimulate diffusion by European consumer demand, if European consumers are interested in Dutch pork. Another option is to promote organic farming among Dutch consumers. Currently, Dutch organic pig farmers comprise around 4% of the total number of pig farmers, and Dutch pigs comprise 1% of all pigs kept in the Netherlands. In addition, the market share of organic in supermarkets lies around 3% in 2020 (Noordzij, 2020). This means that there is potential for growth in combination with financial policies that stimulate demand (see below).

Since the organic market is a regulated market, and when there is a waiting list for conventional farmers to convert to organic farming, consumer demand is the most important limiting factor. In the case of a waiting list, policy instruments should target consumer demand. Communicative policy instruments that target norms among consumers, could stimulate demand. While financial policy instruments that target consumer demand, could take account consumers' susceptibility to price changes (Bunte, van Galen, Kuiper, & Tacken, 2010). The latter could include, e.g., reduced taxes on alternative market produce, or an increase in tax on negative externalities of conventional produce (through cross-price elasticities of demand). Research on current price elasticity of demand, and cross price elasticity of demand could support the choice for a policy instrument that stimulates demand. In case of an empty waiting list, policy instruments should target farmers. Communicative policy instruments can target norms among

the farmer population through advice or meetings between organic and conventional farmers. Financial policy instruments can help farmers to make the investment required for conversion. Finally, policy instruments that ease the entrance of new farmers into the pig farmer population in combination with communicative policy instruments can serve to stimulate the diffusion of added-value markets. It must be noted that at the moment it is hard, even for successors, to start farming because of the high capital investments required for existing buildings and/or land. Initiatives and policies that focus on the financial ease of entrance are, therefore, most promising.

5.6 FUTURE RESEARCH

Directions for future research can be divided into empirical research and agent-based modelling research. Empirical research is needed for up to date information on the role of prices in consumer demand. In addition, empirical research is needed to understand how supply chain relations affect the profitability of alternative farming strategies, and on the role and structure of farmers' network for the exchange of ideas between different minded farmers. Agent-based modelling research can provide insight into the diffusion of added-value market produce among consumers, explore the effect of possible policy scenarios, and refinement of the social influence mechanism.

5.6.1 EMPIRICAL RESEARCH

5.6.1.1 THE ROLE OF PRICE IN CONSUMER DEMAND

The value for price elasticity of demand in this research was based on a study done in 2006 (Bunte et al., 2010). Since price elasticities can change over time, up to date price elasticities are needed. In addition, information on cross price elasticities for demand of organic pork, e.g. the effect of a price increase in conventional pork on demand for organic pork, can inform policy-makers about the most effective policy instrument. Given recent developments in meat alternatives, these should be included in this type of research.

5.6.1.2 SUPPLY CHAIN RELATIONS AND REGULATION

Research on different supply-chain integrations, and regulation policies give insight in the effect of supply-chain relations on the profitability of organic farming. For example, regulation affects price stability, and, therewith, trust in added-value markets for farm continuity.

5.6.1.3 NEW ENTRANTS

Research on the formation of farming styles among farm successors gives insight in how the farming styles of successors are shaped and how they influence diffusion of added-value markets. An interesting direction for research is to identify the context(s) that form(s) the successor's farming style, including their peers. One way to approach this research is to interview successors before higher education (e.g. from 16-18 years) and after, as to see whether and how their ideas of good farming practices change. Given the importance of successors in diffusing alternative farming strategies, research into possibilities that make it easier for new entrants (successor or not) to enter farming is interesting as well.

5.6.1.4 NETWORK AND FARMER CHARACTERISTICS

Research on the characteristics of farmers' networks gives insight in whether and how often farmers talk to farmers with different ideas about 'good farming practices'. In addition, it can give information on whether farmers change their network, how often, and if this differs among the farmers. This is relevant for knowing whether ideas can spread from one reference group to another.

Research on farmer characteristics, such as the percentage of farming styles within a population, the innovativeness of pig farmers, etc. serves as input for the instantiation of a farmer population in a model.

5.6.2 AGENT-BASED MODELLING

5.6.2.1 DIFFUSION OF ADDED-VALUE MARKET PRODUCE AMONG CONSUMERS

Research on the diffusion of e.g. organic produce among consumers would be interesting to understand the change of consumer buying behaviour. Consumers, just as farmers, can be divided into different groups, which influence each other through interaction in their

networks. An agent-based modelling research can explore the effect of local interactions, and possibly policy scenarios, on the diffusion of organic produce among consumers. The social influence mechanism in this research can serve as a basis for interaction in the agent-based model, as well as up-to-date (cross) price elasticities.

5.6.2.2 EFFECT OF POPULATION AND NETWORK CHARACTERISTICS ON DIFFUSION

Agent-based modelling research on different instantiation of farmer characteristics, e.g., farming styles, markets and network formation, give insight in the sensitivity of diffusion of added-value markets to different initial situations.

5.6.2.3 REFINEMENT OF SOCIAL INFLUENCE MECHANISM

A final direction for further research is the refinement of the social influence mechanism developed in this research. First, it would be helpful to use a case that includes multiple patterns of reproduction. In the case of the organic pig sector, these patterns could include a change in organic market reputation, the number of farmers with a different farming styles in organic, and the evolution of attitudes among conventional farmers regarding organic production. Then the social influence mechanism should be refined by including multiple reference groups within one agent, and by operationalising a mechanism where context can determine the salient reference group within an agent, and there with the status symbol and similarity aspects that drive behaviour.

5.7 CONCLUSIONS

This thesis demonstrated how important it is to place individual farmers within their dynamic social environment in order to understand the diffusion of added-value markets. By linking social influence to specific reference groups, identifying factors that cause dynamics, and including feedback mechanisms of the effects of behaviour on the factors the influence behaviour, it was possible to allow for the dynamic influence of farmers' social environment. The farmers' social environment can explain why new entrants can bring about change in the Dutch pork sector and not the current farmer population. First of all, the absence of a successor limits investment possibilities. Secondly, pig farmers' relatively static farming style, i.e., pig farmers' relatively static dominant reference group,

can restrict change. New entrants, on the other hand, can stimulate the diffusion of added-value markets by diversifying farming styles and by including different peers than their predecessors. Apart from the farmers' social environment, pig farmers are restricted by their farm resources, their investment rhythm, and trust in policies and markets, i.e. their contextual environment. Together they influence the perceived financial benefit of an alternative farming strategy.

The perceived financial benefit of an added-value market is an important mediating factor for diffusion to occur. Over time this factor is influenced by a complex interplay between social dynamics among farmers on the one hand, and supply chain relations and consumer demand on the other. It is, therefore, important to not only go beyond the individual farmer to understand diffusion of added-value markets, but to go beyond the farmer population and include supply-chain actors including consumers. In a regulated market, consumer demand limits diffusion while supply chain relations influence the perceived financial benefit of an added-value market. In an unregulated market, farmer interactions can influence excess supply, while the price elasticity of consumer demand influences the perceived financial benefit of an added-value market.

Finally, this thesis revealed that the social identity approach is a useful framework to link individuals to their social environment, while allowing for farmer heterogeneity in farming styles. It does so by linking the social part of farmers' self-concept to the influence of reference groups in social interaction. The common driving force for individual farmers in interaction is being part of a group. In group related influence, norms, status and similarity in person and context play a role. This approach allows for farmer heterogeneity in status symbols, while including group related social influence. The approach is, hence, able to explain why some farmers opt for profit maximisation while others prefer to increase the intrinsic needs of their animals.

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SUMMARY

Dutch pig farmers face multiple challenges. Society expects them to produce cheap meat, while criticizing them for the negative externalities of production, e.g., poor air quality, impaired animal welfare, risk for zoonoses, and excess nitrogen. Often, farm improvements that decrease those negative externalities increase the cost price of pigs. At the same time, pig farmers experience pressure on their income through an increasingly competitive international market with volatile feed and meat prices. Policy-makers and scientists have proposed a way out of this impasse: added-value markets. An added-value market is a market that decreases one or more negative externalities of production at the farm level, while offering farmers a price premium for their produce. In this way, farmers can earn back the extra costs they make for improving their production practices. However, in the past, policies have tried to stimulate added-value market adoption with subsidies. This has resulted in over-supply and a decreased image of organic pig farming as a viable alternative to conventional. Also, previous research has found that farmers are reluctant to convert to another market segment, because they feel peer pressure to remain conventional or defend their choice for alternative farming strategies like organic. In this thesis, we, therefore, try to gain a better insight in the diffusion of added-value markets by including farmer-to-farmer interaction and market price dynamics.

So far research has focused on farmers' individual considerations, farm(er) characteristics, and the contextual environment, or a combination of these factors: e.g. the relation between the adoption of alternative farming practices and, e.g., farmers' age, farm resources, motivations, beliefs, attitudes, and the expected financial advantage of the alternative. Research looked also into farmer heterogeneity. This type of research has, for example, showed that farmers differ in their self-concept and their related notions of 'good farming practices'. However, all of these studies were done at one point in time and did not consider a change in time or the effect of interactions between farmers on decision-making behaviour. In contrast, previous research indicates that farmer-to-farmer interaction plays a role in decision-making, and more specifically, that social influence is related to specific reference groups. Therefore, to understand the effect of farmer decision-making behaviour on the diffusion of added-value markets we need to incorporate all essential factors that influence behaviour while allowing for reference group related social influence.

We use two existing social-psychological theories to conceptualise farmer decision-making behaviour and to account for social interaction between farmers: the Reasoned Action Approach, and the Social Identity Approach. The Reasoned Action Approach accounts for different factors that influence behaviour. The Social Identity Approach links the social part of the self-concept, i.e. reference groups, to social influence as a consequence of interaction. According to Social Identity Theory humans have a universal drive to evaluate their opinions and attitudes to increase their self-esteem, confidence and status as a group member. Disagreements between members of a group can result in an attempt to reduce disagreement through social influence. This provides an interesting framework to understand the mechanisms through which social influence affects behaviour.

Research has shown that farmers are heterogeneous in their traits; that they are influenced by many factors, among which social interaction between farmers, and that they adapt to changes in their environment. Together this can affect macro-level outcomes such as the diffusion of added-value markets. Systems that are comprised of heterogeneous individuals, who adapt to changes in their environment, who interact, and where the effects of behaviour feedback on the factors that influence behaviour, can be called Complex Adaptive Systems. The Dutch pork sector can be seen as such a system because it consists of different components that interact with each other, e.g. farmers, advisors, market prices and government policies. It is adaptive, because farmers respond to changes in their environment and they do so heterogeneously. It is complex, because the effect of interaction between system components can be non-linear and, therefore, hard to predict. Compared to studies that are done at one point in time, a Complex Adaptive Systems approach to understand the diffusion of added-value markets requires a broadening of research focus. The scope of research moves from a focus on individual considerations to a focus on the agricultural system.

Due to the complex nature of the effect of these interactions, the relation between farmers' adaptation behaviour (including farmer-to-farmer interaction and farmer-market price dynamics) and the diffusion of added-value markets is poorly understood. This thesis aims to increase our understanding of the diffusion of added-value markets by taking a complex adaptive system approach. We used a combination of methods to answer the research questions.

In Chapter 2 we used literature research on farmer decision-making behaviour, social-psychological theory, and semi-structured interviews with pig farmers and pork sector experts to construct a conceptual framework of pig farmer decision-making in a time-dependent context. The results show that for a time dependent modelling context it is important to distinguish between static and dynamic factors that influence decision-making and include feedback mechanisms. Adopting the reasoned action approach, we distinguished personal, social and contextual factors. Personal factors include static personality factors and the perceived economic advantage of an alternative investment strategy. Social factors are related to reference groups. The social identity approach states that farmers are influenced by their dominant reference groups, which relate to the farmer's dominant self-concept. We identified stable pig farmer reference groups by way of pig farmers' differences in farming style: idealists, craftsmen and entrepreneurs. The semi-structured interviews with pig farmers and pork sector experts pointed to the restrictions farmers experience by contextual factors. The contextual factors identified were farmers' path dependency given by farmers' investment rhythm in their stable(s), and trust in policies and market. The depreciation period of an investment, such as a stable, co-determines when a farmer can rebuild his/her stable for market conversion. But farmers are also afraid that policy makers could raise the minimal requirements set by law to the requirements set in an added-value market, which would abolish the added value of the market. Finally, semi-structured interviews pointed to the importance of reference group related influence: a farmer did not want to convert to organic because s/he could not pursue his/her entrepreneurial ambitions; and experts argued that conversion to an intermediate market is a big step for farmers as this would mean a step away from their craftsmen farming style.

In Chapter 3, we developed a simulation game to analyse the extent to which social interactions can influence the diffusion of investment strategies. The simulation game provided an experimental setting that grasped the complexity of the Dutch pork system while offering control over e.g. market price dynamics, and the choices for investment. The game was played with pig farmers and pork sector experts. Participants in the game were given two goals: to financially manage their farm to avoid bankruptcy, and to collectively manage the sector's acceptance score. This is a measure of the sector's reputation within society. Participants in the game could choose between scale enlargement that worsened the sector's reputation, and added-value markets (an intermediate and niche market

segment) and smaller investments that increased the sector's reputation. They experienced predefined price fluctuations in the conventional and intermediate market segment, and fluctuations in the niche market segment as a consequence of predefined fluctuations in demand and market conversion of game participants that influenced changes in supply. The game was developed with the aim to incite participants to communicate. We played the game with seven groups of pig farmers, sons of pig farmers and pork sector advisors with 4-8 participants per session. All game sessions were video and voice recorded and interactions between participants were transcribed per game session. To analyse the effect of social interaction on diffusion of investment strategies we categorised diffusion in game sessions according to no, low, or high adoption.

During the sessions, we looked at the role of the investment strategy, communication between participants, and opinion leaders on the diffusion of investment strategies within game sessions. The results show that (1) only investment strategies with a financial benefit did, under influence of social interaction, result in high adoption; (2) for high adoption to occur, communication between participants was necessary; (3) opinion leaders played an essential role in the high adoption of investment strategies; and (4) there was a common understanding among participants in favour of scale enlargement. The gaming methodology triggered participants to communicate their tacit knowledge, i.e. assessment criteria that are important in real-life investment decisions, and to experiment with investment strategies.

In Chapter 4 we developed an agent-based model on organic market conversion in the Dutch pork sector to analyse what factors influence diffusion of organic farming, and how social interaction and context influence the diffusion of investment strategies. The agent-based model modelled heterogeneous pig farmers. Pig farmers interact in each time step, which represents one month, and are influenced according to the social identity approach. Farmers in the model have three reference groups: farmers who are similar in farming style, farmers who are similar in farm size and farmers who are similar in market. For the farming style reference group the status symbols were operationalised, e.g., for craftsmen this is technical production results. Farmer A has a higher chance to be influenced by farmer B when the credibility of farmer B is higher. The credibility of farmer B increases when farmers A and B have the same farming style, and context (farm size and market). Also, the credibility of farmer B increases when farmer B has a high status in terms of the farming style's reference group of farmer A. When farmer

A is innovative, status is more important for the credibility of farmer B than similarity. Another interaction mechanism accounted for in the model is the effect of changes in organic supply (by conversion decisions of farmers) on farm gate price for organic pigs. This is facilitated by a constant elasticity demand function. Model results that we looked at in particular were the size of the organic market (number of organic farmers and pigs) and diversity of farming styles in the organic market (i.e. number of organic idealists, craftsmen and entrepreneurs). First, we performed an exploratory analysis on the effect of social influence parameters on model results. Then we performed a sensitivity analysis and expert validation on model outputs. The exploratory analyses of social influence parameters showed that an increase in likelihood for influence in interaction increases the number of organic farmers and pigs and increases the diversity of organic farmers' farming styles. In addition, the exploratory analysis showed that when farmers regard all other farmers as reference groups irrelevant of farming style, the diversity of organic farmers' farming styles also increases. The sensitivity analysis showed that the interaction between the price elasticity of demand for organic pork meat and social influence dynamics is the most influential factor stimulating the diffusion of organic farming. This is followed by the importance of new entrants. New entrants stimulate organic farming through a different (but existing) farming style than their predecessor and through different peers than their predecessor. Expert validation showed that organic pork meat demand, given a static consumer price, limits the diffusion of organic farming, while waiting lists regulate supply. Differences between supply and demand affect the profitability of organic farming among supply chain actors including farmers. Also, experts argued that successors indeed diversify the farming styles in the farmer population by adding a new farming style than their predecessors, which is shaped by changing societal perceptions towards pig farming.

In Chapter 5 we discussed the main findings of this thesis. We showed that the social environment of the individual farmer can explain excess supply or excess demand in added-value market produce through the reference group related social influence. We showed that the social identity approach is a comprehensive framework for reference group related social influence via interaction, because it allows for farmers' diversity in farming styles while providing a common human motivation for behaviour: group membership. In addition we showed that farmers' social environment and their investment rhythm can explain why new entrants, and not current farmers, positively influence the diffusion of added-value markets. Also, we demonstrated that it is important

to go beyond the farmer population to understand the diffusion of added-value markets. Research should encompass supply chain actors and regulation to gain insight in the profitability of alternative farming strategies; it should, moreover, include consumers, consumer dynamics, and their sensitivity to prices, because they currently restrict the diffusion of added-value markets. Finally, based on our experience we conclude that combination of literature research semi-structured interviews and simulation games, is required to design an agent-based model for farmer behaviour. The agent-based model has the unique strength to operationalise the cognitive mechanisms through which local interactions can influence behavioural change, as opposed to the other methods. However, the translation of conceptual models of farmer decision-making into computational rules for agents requires additional creativity and, therewith unavoidable assumptions for which no data exists. The method can, therefore, best be regarded as an important tool for boundary-work on mechanisms for interactions that help to understand macro-level patterns. Agricultural practitioners who try to stimulate the diffusion of added-value markets can learn from the social interaction mechanism developed in this thesis. They can try to stimulate interaction between farmers with an alternative farming strategy and conventional farmers who are open to new ideas. In such conversations it is important to accentuate the similarities between the two types of farmers (e.g. location, cultural traditions, farm contexts etc.); it is also crucial to know the status symbols of the conventional farmers. For example, an entrepreneurial farmer is likely to be more interested in the viability or prospects of an added-value market than pigs' intrinsic needs. Furthermore, we argued that financial and communicative policy instruments should focus on consumers and new entrants as they provide the main impetus for change.

SAMENVATTING

Hoofstuk 1 beschrijft de aanleiding van het onderzoek, de onderzoeksvragen en de methoden: Nederlandse varkenshouders staan voor verschillende uitdagingen. De maatschappij verwacht goedkoop varkensvlees van hen, maar tegelijkertijd bekritiseren ze hen vanwege allerlei negatieve effecten die de productie ervan veroorzaakt zoals: slechte luchtkwaliteit, laag dierenwelzijn, risico op zoönose en een stikstofoverschot. Echter, vermindering van deze negatieve effecten leidt tot een hogere kostprijs van het eindproduct. Tegelijkertijd hebben varkenshouders te maken met druk op hun inkomen door een steeds competitievere, internationale markt met fluctuerende voer- en vleesprijzen. Een oplossing van beleidsmakers en wetenschappers voor deze impasse zijn markten met toegevoegde waarde d.m.v. vraag gestuurde productie. Een markt met toegevoegde waarde, ook wel een marktconcept genoemd, is een markt die één of meerdere negatieve externe effecten op de productie aanpakt op bedrijfsniveau en die er voor zorgt dat boeren een hogere prijs krijgen voor hun producten. Op die manier kunnen varkenshouders de extra kosten die zij maken voor het verlagen van negatieve externe effecten terugverdienen via de markt. Een voorbeeld van een marktconcept is de biologische markt. In het verleden hebben beleidsmaatregelen marktconcepten gestimuleerd door middel van subsidies. Dit heeft echter geleid, in het geval van de biologische varkenshouderij, tot overproductie en een verslechterd imago als een goed alternatief voor de conventionele markt. Eerder onderzoek heeft laten zien dat boeren terughoudend zijn bij het omschakelen naar een markt met toegevoegde waarde, mede omdat zij sociale druk ervaren om conventioneel te blijven produceren of omdat zij hun keuze moeten verdedigen ten opzichte van collega's. In deze thesis richten wij ons daarom op het beter begrijpen van de verspreiding van marktconcepten onder Nederlandse varkenshouders door rekening te houden met interacties tussen varkenshouders en marktprijsdynamieken.

Onderzoek in het verleden heeft zich vooral gericht op individuele overwegingen van boeren, eigenschappen van boeren, bedrijfskenmerken en de contextuele omgeving, of een combinatie hiervan. Onderzoek heeft zich bijvoorbeeld gericht op de relatie tussen het toepassen van nieuwe landbouwmethoden en, o.a. leeftijd van de boer, financieel kapitaal, motivaties, overtuigingen, en/of attituden van de boer. Onderzoek heeft ook gekeken naar diversiteit onder boeren. Dit soort onderzoek liet bijvoorbeeld zien dat boeren

verschillen in hun zelfconcept en ideeën die gerelateerd zijn aan wat 'een goede boer' is. Echter, al deze onderzoeken zijn momentopnames en hebben geen rekening gehouden met veranderingen in de loop van de tijd of het effect van sociale interacties tussen boeren op hun besluitvorming. Terwijl dit wel belangrijk is. Daarnaast wijst onderzoek uit dat sociale beïnvloeding gerelateerd is aan specifieke referentiegroepen. Wanneer we het effect van de besluitvorming van boeren op de verspreiding van marktconcepten onder varkenshouders willen begrijpen is het belangrijk om alle essentiële factoren die gedrag beïnvloeden te integreren en tegelijkertijd rekening te houden met sociale beïnvloeding gerelateerd aan referentiegroepen.

In deze thesis gebruiken we twee bestaande sociaalpsychologische theorieën om de rijkdom aan factoren die besluitvorming beïnvloeden te conceptualiseren en om rekening te houden met de sociale interactie tussen boeren: de 'Reasoned Action Approach' en de 'Social Identity Approach'. De 'Reasoned Action Approach' integreert verschillende factoren die besluitvorming beïnvloeden. De 'Social Identity Approach' relateert het sociale onderdeel van het zelfconcept, d.w.z. referentiegroepen, aan sociale beïnvloeding als een consequentie van interactie. Volgens de 'Social Identity Approach' hebben mensen een universele drijfveer om hun opinies en attituden te evalueren om hun zelfvertrouwen en status als groepslid te vergroten. Meningsverschillen tussen groepsleden kunnen resulteren in een poging om de verschillen op te lossen door middel van sociale beïnvloeding.

Boeren zijn dus heterogeen in hun eigenschappen; ze worden beïnvloedt door veel verschillende factoren waaronder sociale interactie tussen boeren en ze reageren op veranderingen in hun omstandigheden. Samen kan dit op macro niveau uitkomsten beïnvloeden, zoals op de verspreiding van marktconcepten. Systemen die bestaan uit heterogene individuen die zich aanpassen aan hun omgeving, die interacteren en waar de effecten van besluitvorming worden teruggekoppeld naar de factoren die hun gedrag beïnvloeden, worden ook wel Complex Adaptieve Systemen genoemd. De Nederlandse varkenshouderijsector kan gezien worden als zo'n systeem, omdat ze bestaat uit verschillende componenten die interacteren, bijvoorbeeld boeren, adviseurs, marktprijzen en beleidsmaatregelen. Het is adaptief, omdat boeren reageren op veranderingen in hun omgeving en ze doen dat heterogeen. Het is complex, omdat het effect van de interactie tussen verschillende systeemcomponenten niet lineair kan zijn en daarom moeilijk te voorspellen is. Vergeleken met de meest voorgaande onderzoeken naar het gedrag

van boeren die gedaan zijn op één moment in de tijd, vereist een Complex Adaptief Systeemperspectief: een verbreding van onderzoek focus. De reikwijdte van de studie verschuift van een focus op het individu naar een focus op het agrarisch systeem.

Het doel van deze thesis is om ons begrip van de verspreiding van marktconcepten beter te begrijpen door een Complex Adaptief Systeemperspectief (CAS) te gebruiken. We beantwoorden de volgende onderzoeksvragen:

1. Welke factoren beïnvloeden varkenshouders in hun strategische investeringskeuzen vanuit een CAS perspectief?;
2. Tot op welk niveau heeft sociale beïnvloeding onder varkenshouders invloed op de verspreiding van investeringsstrategieën?;
3. Hoe beïnvloeden context en interacties een rol in de verspreiding van de biologische varkenshouderij?

We gebruiken een combinatie van methoden om de onderzoeksvragen te beantwoorden.

In Hoofdstuk 2 hebben we een conceptueel raamwerk gemaakt van de besluitvorming van varkenshouders in een dynamische context. Hiervoor is een combinatie gebruikt van sociaalpsychologische theorieën, literatuuronderzoek naar factoren die het gedrag van boeren beïnvloeden en semigestructureerde interviews met varkenshouders en experts in de varkenshouderij. Voor dit raamwerk is het belangrijk is om een onderscheid te maken tussen statische en dynamische factoren die besluitvormingsgedrag beïnvloeden en om terugkoppelingsmechanismen te integreren. Door het gebruik van de 'Reasoned Action Approach' hebben we een onderscheid gemaakt tussen persoonlijke, sociale en contextuele factoren die besluitvormingsgedrag beïnvloeden. Persoonlijke factoren bestaan uit karakter (stabiel over de tijd) en de verwachtte opbrengst van een investeringsstrategie (dynamisch). Voor invulling van de sociale factoren die gedrag beïnvloeden wordt de 'Social Identity Approach gebruikt'. Sociale factoren zijn sociale beïnvloedingen gerelateerd aan referentiegroepen (dynamisch). Het dominante zelfconcept van de boer bepaald de meest belangrijke referentiegroep die invloed kan uitoefenen op gedrag. Daarnaast kunnen, afhankelijk van de context, andere referentiegroepen belangrijk zijn voor besluitvorming. In de literatuur worden drie belangrijke type boeren onderscheiden die elk verschillen in hun idee over wat een 'goede' boer is en die elk verschillen in hun 'stijl van boeren': de idealisten, de ambachtslieden, en de ondernemers. Volgens de 'Social Identity Approach' vormen andere boeren met dezelfde 'stijl van boeren' de

belangrijkste referentiegroep van een boer. De resultaten van de semigestructureerde interviews met varkenshouders en experts in de varkenshouderij wezen vooral op het belang van contextuele factoren: het investeringsritme, het vertrouwen in beleid en de markten. De afschrijvingstermijn van een investering, zoals een stal, bepaalt mede wanneer een varkenshouder bijvoorbeeld kan omschakelen naar biologisch, mocht de varkenshouder dat willen. Daarnaast zijn varkenshouders wantrouwend tegenover beleid, omdat zij verwachten dat minimaal wettelijke eisen worden bijgesteld naar die van een markt met toegevoegde waarde, waardoor de toegevoegde waarde teniet wordt gedaan. De semigestructureerde interviews bevestigden dat sociale beïnvloeding gerelateerd is aan referentiegroepen: een varkenshouder identificeerde zich niet met biologische varkenshouders waardoor hij niet wilde omschakelen naar de biologische markt. Daarnaast gaven experts aan dat de stap naar het tussensegment in de varkenshouderij een te grote stap is voor veel varkenshouders, omdat het afwijkt van hun traditionele ambachtelijke en/of ondernemende stijl van boeren.

In Hoofdstuk 3 keken we in hoeverre sociale beïnvloeding effect heeft op de verspreiding van investeringsstrategieën onder varkenshouders. Hiervoor hebben we een simulatiespel ontwikkeld. Met het simulatiespel werd een versimpelde weergave van de Nederlandse varkenshouderij gegeven in een experimentele setting. De deelnemers aan het simulatiespel kregen ieder een eigen varkensbedrijf en kregen de keuzen uit verschillende investeringsstrategieën die van invloed zijn op de economische situatie van het eigen bedrijf en maatschappelijke acceptatie van de sector. Dat laatste representeert de reputatie van de varkenshouderij in de maatschappij. De investeringsstrategieën waren schaalvergroting die de maatschappelijke acceptatie zou verkleinen, en omschakeling naar marktconcepten of kleinere investeringen die de maatschappelijke acceptatie zou vergroten. Tijdens het spel kregen de deelnemers te maken met deels vooraf vastgestelde marktprijsdynamieken. Zo werd de prijsfluctuatie van conventioneel en tussensegment (een marktconcept dat hogere eisen stelt dan de minimaal wettelijke eisen) vooraf vastgesteld, en was de prijs van niche (een marktconcept met hogere eisen dan tussensegment op het gebied van dierenwelzijn en/of milieu) afhankelijk van de investeringsbeslissingen van deelnemers tijdens het simulatiespel. Het spel werd gespeeld met varkenshouders en experts in de varkenshouderij. De deelnemers van het spel hadden twee doelen: faillissement voorkomen en gezamenlijk de maatschappelijke acceptatie van de sector beheren.

Het spel was zo ontwikkeld dat het de communicatie tussen deelnemers bevorderde. We hebben het spel met zeven groepen van varkenshouders en adviseurs in de varkenshouderij gespeeld met 4-8 deelnemers per sessie. Alle spelsessies werden met video- en voicerecorder opgenomen en interacties tussen deelnemers werden uitgeschreven per spelsessie. Om het effect van sociale interactie tussen deelnemers op de verspreiding van investeringsstrategieën te kunnen analyseren, hebben we de verspreiding van investeringsstrategieën gecategoriseerd in geen, lage of hoge verspreiding. Tijdens de analyse keken we naar de rol van de investeringsstrategie, de rol van de communicatie tussen de deelnemers, en de rol van opinieleiders op de verspreiding van de investeringsstrategie tijdens spelsessies. De resultaten laten zien dat:

(1). alleen investeringsstrategieën met een financieel voordeel hebben onder invloed van sociale interactie, geresulteerd in een hoge verspreiding;
(2). voor een hoge verspreiding van een investeringsstrategie was communicatie tussen deelnemers noodzakelijk;
(3). opinieleiders hebben een essentiële rol gespeeld in de hoge verspreiding van een investeringsstrategie;
(4). er was een gezamenlijke verstandhouding onder de deelnemers in het voordeel van schaalvergroting.

De spelmethodologie leidden ertoe dat deelnemers de factoren die zij in overweging nemen bij het maken van investeringskeuzen met elkaar deelden. Eveneens bracht het deelnemers ertoe te experimenteren met investeringsstrategieën.

In Hoofdstuk 4 hebben we een agent-based model ontwikkeld voor de omschakeling naar de biologische markt in de Nederlandse varkenshouderij. Dit model dient om te analyseren welke factoren van belang zijn bij de verspreiding van het biologische marktconcept, en hoe sociale interactie en context de verspreiding van biologische marktconcepten beïnvloeden. In het agent-based model zijn we uitgegaan van verschillen tussen individuele varkenshouders op o.a. leeftijd, bedrijfsgrootte, en stijl van boeren (hun idee over wat een goede varkenshouder behelst). Varkenshouders interacteren elke tijdsstap in het model, wat overeenkomt met 1 maand, en beïnvloedden elkaar volgens de 'Social Identity Approach'. Boeren in het model hebben drie referentiegroepen: boeren die gelijk zijn in hun stijl van boeren (we onderscheiden de idealist, ambachtsman, of ondernemer); boeren die een gelijke bedrijfsgrootte hebben; boeren die voor hetzelfde

marktconcept produceren. Voor de 'boerenstijl' referentiegroep zijn de statussymbolen geoperationaliseerd; voor ambachtslieden zijn dit bijvoorbeeld de technische resultaten, een beter technisch resultaat geeft een hogere status (bijvoorbeeld een hoog aantal biggen per zeug geeft een hoge status).

In het model betekent de 'Social Identity Approach' dat boer A een hogere kans heeft door boer B beïnvloed te worden wanneer de geloofwaardigheid van boer B hoog is. De geloofwaardigheid van boer B is hoger wanneer boer A en B dezelfde boerenstijl hebben en dezelfde context (bedrijfsgrootte en marktconcept). De geloofwaardigheid van boer B is ook hoger wanneer boer B een hoge status volgens de boerenstijl van boer A heeft. Wanneer boer A innovatief is, is de status van boer B belangrijker dan de gelijkenis tussen boer A en B voor zijn/haar geloofwaardigheid. Naast sociale interactie hebben we ook rekening gehouden met prijsdynamieken in het model. Dat betekent dat er interactie is tussen biologische productie en de biologische varkensprijs die varkenshouders krijgen (bijvoorbeeld een verhoging van het aantal biologische boeren bij gelijkblijvende vraag leidt tot een lagere varkensprijs). Dit wordt gefaciliteerd door een constante elastische vraagfunctie, waarbij we uitgaan van een hoge prijselasticiteit van biologisch varkensvlees (een kleine verhoging leidt tot een grote daling in de vraag).

In de analyse hebben we gekeken naar het effect van de modelparameters op veranderingen in modelresultaten: de grootte van de biologische markt (het aantal biologische boeren en het aantal biologische varkens), en de verscheidenheid aan boerenstijlen in de biologische markt (het aantal biologische idealisten, ambachtslieden en ondernemers). Eerst hebben wij een exploratieve analyse uitgevoerd naar het effect van sociale beïnvloedingsparameters op modelresultaten. Vervolgens hebben we een sensitiviteitsanalyse uitgevoerd samen met een expertvalidatie op de modelresultaten. De exploratieve analyse van de sociale beïnvloedingsresultaten liet zien dat een verhoging in de kans op sociale beïnvloeding door interactie het aantal biologische boeren en varkens verhoogt. Daarnaast verhoogt het ook de verscheidenheid aan boerenstijlen in de biologische varkenssector. De sensitiviteitsanalyse laat zien dat de interactie tussen de prijselasticiteit van de vraag naar biologisch varkensvlees en sociale interactie dynamieken de meest invloedrijke factoren zijn voor de verspreiding van de biologische markt. Daarna zijn opvolgers het meest van invloed op het aantal biologische boeren en varkens. Opvolgers stimuleren de biologische markt door een andere (maar bestaande)

boerenstijl te hebben dan die van hun voorganger, en door een ander netwerk te hebben die hen beïnvloeden. De expertvalidatie laat zien dat de vraag naar biologisch vlees, uitgaande van een stabiele consumentenprijs, de verspreiding van biologische productie onder varkenshouders remt, terwijl wachtlijsten het aanbod van biologisch varkensvlees reguleren. Verschillen tussen aanbod en vraag beïnvloeden de winstgevendheid van de biologische varkenshouderij onder de spelers in de leveringsketen, waaronder varkenshouders. Daarnaast beargumenteren de experts dat opvolgers inderdaad de verscheidenheid aan boerenstijlen in de varkenssector beïnvloeden door nieuwe boerenstijlen toe te voegen. De nieuwe boerenstijl wordt beïnvloed door veranderende maatschappelijke percepties ten aanzien van de varkenshouderij.

In Hoofdstuk 5 hebben we de belangrijkste resultaten van deze thesis uiteengezet. Allereerst heeft deze thesis laten zien dat sociale beïnvloeding via referentiegroepen kan verklaren waarom er een aanbod tekort of overschot is naar biologisch varkensvlees. De 'Social Identity Approach' vormde hiervoor een integraal raamwerk dat rekening houdt met de diversiteit van boerenstijlen onder boeren en, tegelijkertijd, voorziet in een gemeenschappelijke, menselijke motivatie voor gedrag: namelijk groepslidmaatschap. Daar bovenop hebben we laten zien dat de sociale omgeving van de boer kan verklaren waarom opvolgers, en niet huidige varkenshouders, de verspreiding van marktconcepten kan stimuleren. Naast de sociale omgeving, heeft dit onderzoek ook laten zien dat het belangrijk is om verder te kijken dan de boerenpopulatie om de verspreiding van investeringsstrategieën te begrijpen. Toekomstig onderzoek zou ook actoren in de toeleveringsketen en reguleringsmaatregelen moeten omvatten om inzicht te krijgen in de winstgevendheid van marktconcepten. Daarnaast zou onderzoek ook consumenten, consumentendynamieken en hun gevoeligheid voor prijs moeten omvatten, omdat zij mede op dit moment de verspreiding van marktconcepten tegenhouden. Als laatste concluderen wij, op basis van onze ervaring, dat een combinatie aan literatuuronderzoek, semigestructureerde interviews, en simulatiespellen nodig is om een agent-based model van boeren besluitvormingsgedrag te maken. Een agent-based model heeft de unieke capaciteit, in vergelijking met andere methoden, om cognitieve mechanismen achter besluitvorming te operationaliseren, inclusief de rol van sociale interactie op gedragsverandering. Echter, de vertaling van een conceptueel model van boeren besluitvormingsprocessen naar rekenregels voor 'agents' in een computermodel, vereisen

onvermijdbare aannames waarvoor geen data beschikbaar zijn. Agent-based modellen zijn daarom een goed hulpmiddel voor interdisciplinaire samenwerking op het gebied van interactiemechanismen en gedrag, die op macroniveau patronen kan helpen begrijpen.

Landbouwadviseurs die proberen de verspreiding van marktconcepten te stimuleren kunnen leren van het sociale beïnvloedingsmechanisme dat is ontwikkeld in deze thesis. Zij kunnen de interactie tussen boeren met een marktconcept en conventionele boeren die openstaan voor nieuwe ideeën stimuleren. In zulke gesprekken is het belangrijk om gelijkenis tussen boeren te benadrukken (bijv. de locatie, culturele tradities, boerderijcontext etc.); het is ook cruciaal om de statussymbolen van de conventionele boeren te begrijpen. Bijvoorbeeld, het is waarschijnlijker voor een ondernemende boer om meer geïnteresseerd te zijn in de economische kansen van een marktconcept dan in de intrinsieke behoeften van varkens binnen een marktconcept. Als laatste beargumenteren wij dat financiële en communicatieve beleidsmaatregelen zich zouden moeten focussen op consumenten en/of nieuwkomers in de boerenpopulatie, omdat zij de grootste impuls voor verandering zijn.

ABOUT THE AUTHOR

Floor Ambrosius was born on the 31st of March 1985, in Steensel, a small village in the South-East of Noord-Brabant, the Netherlands. She grew up there with her parents, two brothers (one older, one younger) and a younger sister. She attended pre-university secondary education at Rythovius College, in Eersel. Her exam subjects included Dutch, English, mathematics, physics, biology, economics, and chemistry. After finishing high school she travelled Australia and New-Zealand in 2003/2004 before starting her Bachelor in International Development Studies in Wageningen in 2004 with a specialisation in Economics of Development. Her Master was also in International Development Studies, but with a specialisation in Communication and Sociology. She finished her Master with an internship in Puerto Princesa, the Philippines on the implementation of an alternative livelihood project for fishermen and an ethnographic master thesis on the perception of Dutch rural youth regarding multi-cultural society.

After her graduation in 2011 she volunteered for Fairfood International and worked for the RUW Foundation and Urgenda. For the first time she came in contact with the socio-economic problems of the Dutch pork sector. This resulted in her interest for this PhD-thesis, which she started in 2013 at the Information Technology Group, Rural Sociology Group and Animal Production Systems Group of Wageningen University. Her PhD project was part of a larger research program entitled 'Complex Adaptive Systems' funded by the IP/OP CAS of Wageningen University. During her PhD Floor completed her education program, presented her work in international conferences, published in international peer-reviewed journals, and collaborated with groups of farmers and advisors, and Dutch pork sector representatives. She spent three months at CIRAD Green in Montpellier France as visiting researcher.

During her PhD, she became a mother of two beautiful sons (2016, 2017). After her PhD-contract finished in 2017, she started working for Kipster in 2018 as project manager. There she worked on, among other things, an animal-, environmental-, and human friendly concept for pigs, Pigster. In 2021 she started working as Advisor Agriculture and Food for WWF-NL, mainly on new business models for nature-inclusive farming for Dutch arable and dairy farmers.

EDUCATION CERTIFICATE

Floor Hendrikje Willemien Ambrosius
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Agent-Based Modelling, INF-50806	WUR	2013	6
'Agent-based modelling of farmers' social and economic decision making. Pig farming Innovation Systems: the adaption of novel housing systems'	Groningen Centre for Complexity Studies	2013	1
WUR PhD-Day: organising a panel session	WUR	2013	1
'From Theory to Agent-Based Model: a rough simplification adventure'	CAS Workshop Social Unrest Among Humans and Animals, WUR	2014	1
Companion Modelling	PE&RC, WIAS and WASS	2014	1.5
WUR PhD-Day: convening a session	WPC, WUR	2015	1
Game workshops students & farmers	WUR	2015/2016	3
B) General research related competences			
WASS Introduction	WASS	2013	1
Social and Economic Networks	Stanford University	2013	3
Quantitative Data Analysis: Multivariate Techniques, YRM-60306	WUR	2013	6
Workshop Modelling Social Reality	Lorentz Center	2014	1.4
'Innovation in farmer networks: an agent-based modelling approach'	Wageningen International Conference on Chain and Network Management (WiCaNeM), Capri, Italy	2014	1

'Market dynamics in the Dutch pork sector'	European Social Simulation Annual Conference, Barcelona, Spain	2014	1
'Gaming to gain insight in pork farmers' strategic decision-making'	European Social Simulation Annual Conference, Groningen, Netherlands	2015	1
Assistance in course 'Introduction to Agro-Technology'	WUR	2013-2016	1
C) Career related competences/personal development			
Project and Time Management	WGS	2014	1.5
Competence Assessment	WGS	2013	0.3
Techniques for Writing and Presenting a Scientific Paper	WGS	2014	1.2
French II	Wageningen in'to languages	2015	2.1
Organisation ESSA Summer School	Wageningen University	2015	1
Visit/intern CIRAD, Montpellier	CIRAD Green	2015	2
Total			**38.0**

*One credit according to ECTS is on average equivalent to 28 hours of study load

ACKNOWLEDGEMENTS

I think this part of the booklet is actually hard to write after a process of eight years. But wow it is actually done! Many times, more than good for me, I was not sure whether I would ever make it to this point. But here I am, with a real booklet printed. That does make me happy. The process gave me a lot of valuable life experiences, insights and maturation, and of course there are many people I would like to thank who contributed to this directly or on the side-lines.

First of all, I would like to thank my supervisors. Gert Jan, my (daily-)promotor and agent-based modelling enthusiast, thank you for your continuous dedication to guide me to the end of this process, and your flexibility towards my needs during this time. I appreciated your endless belief in me, your accentuation of the positive aspects, and your outside reflections on my PhD struggles. Also, by now, I almost come to understand your remarks on presenting my research with more 'flair' (more in a Gert Jan style I would say). Let's hope I managed during my defence. Eddie Bokkers, I very much appreciated your practical advice on moving forward with this thesis, which felt like blue skies at that time. I learned from you what it takes to do research. I also appreciated your efforts to keep things short (I am afraid I failed on that point), and of course your dedication to guide me to the end of this project. Bettina Bock, I valued your capacity to listen and for keeping an overview. Your efforts to try and understand my motivations and storyline greatly helped me to order my sometimes chaotic mind. Furthermore, you gave me the overview when I only saw the details. Your feedback, to the point and somehow always at the right level of detail, helped me further. Finally, Adrie Beulens, thank you for sharing your stories and experiences with farmers at the start of my thesis. I enjoyed our conversations.

Then I would like to thank my two last co-authors, Mark Kramer and Alisa Spiegel, without whom I would have given up I think. Mark Kramer, your modelling expertise, your encouragement, and the nice collaboration helped me through my last article. I very much enjoyed our meetings, which were both personal and professional. I learned a great 'modelling' deal from you: keeping structure, setting boundaries, and guarding research questions. Furthermore, I liked our discussions regarding agent-based modelling, interpreting modelling results and your outside reflections on doing a PhD. Alisa Spiegel, also your modelling expertise was very helpful for me. You asked me the right questions, you took the time to go through the storyline of the article. Also, you made sure I sticked

to it, which is one of the reasons this booklet is now printed. Furthermore, I learned a lot from your focused feedback on the article and your PhD experiences. Hopefully we somehow meet each other again!

Then I would also like to thank my fellow colleagues in the various CAS workgroups: Sjoukje, Mark, Gert Jan, Francine, Iris, Eline, Yang, Anouschka, Jillian, and Guus. Discussing our different approaches helped me in understanding mine.

A big thank you to all pig farmers, pork sector advisors and experts whom I talked to over the years. Thank you for sharing your time, knowledge and experience with me. Without your contribution, this research would have been impossible. Ludo Poels, thank you for being the first person willing to experiment with the simulation game and introduce it to participants in your workshop. That helped enormously in finding more groups of farmers. Also, Robert Hoste, thank you for sharing your vast experience and knowledge of the pork sector multiple times throughout my research, and making time for it over and over again. It greatly helped me in understanding the financial and economic aspects of pig farming and placing them within an international context.

Thanks also to my paranymphs Iris Boumans and Giulia Salvini, to stand beside me at my defence. Iris, I greatly enjoyed our many talks and lunches. From start to finish I have always felt your support! Giulia, yes what have we not shared over the passed years, you even became my office-mate at one point in time! So glad that you are there to celebrate this with me at the end!

Then I would like to thank all colleagues and fellow PhDs I have had over the years. You gave this process a very nice social twist. I enjoyed the discussions and laughs in the office, the coffee breaks, lunch walks and culinary evenings. You provided my with the necessary stress release, humour, and delicacies. A special thanks to Ilona, Leonie, Natasja, Jeanette, Anne and Claudia, I appreciated your help in all secretarial matters.

The Companion Modelling group cannot be missed here. So much inspiration in one week, and I am thankful for all the nice people I got to know here. This also led to an enriching PhD visit to CIRAD Green in Montpellier. A thank you to Christophe le Page for making this possible, and a thank you to both Christophe le Page and François Bousquet for making time to discuss a gaming approach in the context of my research. Bernard you were a very nice host for my stay in Montpellier. Margot and Hermine you made my visit both French (red wine and cheese) and fun!

I would like to express my gratitude to all my friends and family for their warmth, support, and the adventure and fun they bring into my life! Jackelien, Elisa, and Christine for giving me loving foundations for necessary reflections. Noor, Josien, Anouk, Lieke and Tanja for the welcoming weekends, dinners, and ever-lasting friendships. My Wageningen student buddies for our fun get togethers and crazy memories. Natasha, thank you for designing the wonderful cover for my PhD booklet, I love the result! A special thanks to my parents for showing me that life needs to be celebrated with food, family and friends. In the context of this research, I am very grateful for your endless support with the kids. This gave my the time to finally finish this booklet even during lock-down corona times.

Last but not least, the three rock stars in my life. Daniel, my life partner. Without you there would not have been a booklet. I think this PhD is as much a result of your support as it is of my efforts to finish it. Thank you for always being there for me! Tobi en Sebbe, wat stelt een PhD voor bij ontwapenende glimlachjes, prachtige uitspraken, en een onbeperkte fantasie. Vanaf nu is mama klaar met werken!

The research described in this thesis was financially supported by the 'IP/OP' investment programme 'Complex Adaptive Systems' of Wageningen UR, the Netherlands.

Financial support from Wageningen University for printing this thesis is gratefully acknowledged.

Cover design by Natasha Poposka - de Bats, www.atelierdescribe.nl
Thesis design by Miranda Dood , Mirakels Ontwerp

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