

Aus dem Institut für Agrarökonomie
der Christian-Albrechts-Universität zu Kiel

**Empirical Analysis of Process Quality Aspects in the
German Agri-Food Sector**

Julia Anette Schreiner

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German Agri-Food Sector**

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Julia Anette Schreiner, M.Sc.
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List of acronyms

AES	Agri-environmental scheme
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
CL	Conditional Logit
CA	Conjoint Analysis
DC	Discrete Choice
DCE	Discrete Choice Experiment
FAW	Farm Animal Welfare
FCM	Frequent Cooperation Member Interaction
GM	Genetically Modified
GMO	Genetically Modified Organisms
IIA	Independence of Irrelevant Alternatives
IID	Independent and Identically Distributed
LC	Latent class
ML	Multinomial Logit
NUV	Non Use Values
PCA	Principal Component Analysis
rbST	Recombinant bovine somatotropin
RPL	Random Parameter Logit
RUT	Random Utility Theory
SD	Standard Deviation
SRQ	Supplier Relationship Quality
SSC	Somatic Cell Count
WTP	Willingness to pay
WTA	Willingness to accept
U.S.	United States
UV	Use Values

Chapter 1

Introduction and summary

The German food sector is subject to important challenges driven *inter alia* by policy reforms, changing food production conditions and increasing consumer awareness of food quality. Segments of the public have become increasingly critical of certain aspects of food production; both at the farm and the processing level. Nowadays consumers¹ are more demanding, more critical and more fragmented in their food choices. From the quality perception literature it is well known that quality is a multi-dimensional construct and usually categorized into intrinsic quality cues (part of the physical product) and extrinsic quality cues (everything else). One of the reasons why the use of extrinsic cues for quality inference gains increasingly importance emanates from the linkage between production processes and health as well as food safety (Grunert 2006). Good food quality as it is perceived by consumers revolves around four main concepts, which are taste, health, convenience and, at least for some consumers, process characteristics. The diversity of those characteristics is reflected by a large number of certification schemes established over the last decade setting out a series of technical requirements for producing, processing and transporting food (Bredahl et al. 2001). Based upon information economics theory, Darby and Karni (1973) provide a classification of quality dimensions into search, experience and credence dimensions. Credence dimensions are those dimensions for which the average consumer can never ascertain the quality for himself, but has to trust the judgement of others. In this context, the key factor that makes an attribute a credence attribute is that it is not practicable for consumers to assess the quality of

¹ In the present dissertation the generic masculine form is used which should be understood also as a reference to women.

the product. As an instrument to signal quality, informational labelling is used requiring a reputable certification agent whom consumers can trust (Caswell and Mojduszka 1996). Information remedies in terms of labels can take different forms: for example mandatory disclosure of information about the nature of a product or voluntary claims. Prominent examples are the German Bio seal providing legally defined information on the production process or a private sector label like the quality and safety *Q&S* label standing for a cross stage and cross company quality assurance scheme (BMELV 2011). Process-oriented schemes are established to provide and preserve a certain product quality throughout the entire supply chain (Fischer et al. 2010). The currently most prominent examples of process qualities that affect the German agricultural sector are animal-friendly livestock handling and the abandoning of genetically modified feedstuffs. Although many people are critical towards modern agricultural practices and some consumers are willing to pay price increments for certain process qualities, the availability of milk that is produced without using GMO and high-welfare meat remain limited. There is a perception that incentives for farmers are not sufficient to encourage the desired changes of farming practices. Determinants of farmers' decision behavior to approve or disapprove process quality schemes are central to the present dissertation.

A key methodology used in this dissertation is discrete choice experiments (DCE). DCE have been applied primarily to elicit consumers' preferences for product attributes in marketing research (McFadden 1986). With growing popularity, the methodology has also spread into other fields of application. Nowadays discrete choice analysis is widely used across diverse areas to study the behavioral responses of individuals, households and other organizations covering topics like health care services (Amaya-Amaya et al. 2008), transportation demand (Ben-Akiva and Lerman 2000) to mention but a few. In agricultural economics the application of the DCE method is still rare. Birol et al. (2008) provide a review on studies employing DCEs on issues related to agricultural and food policies in Europe including an investigation of farmers' trade-offs between water pollution from agricultural sources and investment in environmental efforts in a rural region of Romania (Toma and Mathijs 2004). Another study deals with German consumers' willingness to pay (WTP) for improved food safety in meat production signaled through quality labels (Enneking 2004). The present dissertation presents discrete choice studies applied to issues related to farmers' willingness to change farming practices in order to ensure the provision of certain process qualities. More specifically, the dissertation aims to investigate dairy farmers' acceptance of GM-free milk production and further to enhance animal welfare in dairy cattle farming. Moreover, farmers' as well as con-

sumers' preferences for animal welfare in pig fattening are assessed to predict supply and demand for high-welfare pork. Additionally a case study was conducted to investigate farmers' support of a strategic cooperation between dairy companies to achieve higher efficiency in milk collection. The following paragraphs provide an overview of existing DCE studies exploring farmers' willingness to accept (WTA) production schemes in livestock farming that require changes in farm management. Afterwards, the most recent studies on consumers' preferences for farm animal welfare (FAW) are summarized and assessed.

A number of DCE studies have been carried out to inform the efficient design of production schemes or contracts by providing insights on farmers' preferences for contract elements or more generally their responses to changes in farm management. Norwood et al. (2006) investigated cattle farmers' willingness to participate in a voluntary checkoff program in the U.S. The term checkoff refers to a producer-funded marketing program including commodity promotion, research, and consumer information (Cattlemen's Beef Board 2015). They obtained choice data from 670 farmers in order to answer what type of checkoff program would receive the greatest support. Farmers were asked to pay a checkoff fee that is refunded in full on request or allocated across advertising, research and other activities to promote the checkoffs. A threshold level of provision has to be met or all fees would be refunded, even if this was not demanded. Farmers' participation was highest when the refund option was included and the majority of farmers placed a significantly greater priority on spending money on advertising than on other options. Olynk et al. (2012) reported results of a study on welfare effects if the use of a bovine growth hormone (rbST) was removed from the set of technologies used by Michigan dairy farmers. Although they found heterogeneous impacts on income between farmers who previously treated their cows with hormones and those who did not, significant welfare losses for all producers were evident. Other applications of DCEs are targeted on revealing producers' acceptance of business contracts. For example, Roe et al. (2004) investigated hog producers' preferences for marketing contract attributes affecting the distribution of profits. Besides the effect of contract elements on the likelihood of acceptance, farmers showed strong preferences for a cooperative organizational form. In particular producers who attach importance to a trustful relationship with their contractors are more likely to choose a contract offered by a cooperative. In their study on farmers' participation in voluntary agri-environmental schemes (AES) Ruto and Garrod (2009) could identify a group of scheme opponents, but also a larger group of farmers who accept contracts offering relatively little flexibility and a higher administrative effort. In addition to contract attributes, farmers' age and

education affect their willingness to enter into a contract. DCEs have also been applied to afforestation contracts by Broch and Vedel (2012). The authors investigated the influence of contract elements on farmers' acceptance. Enhancing biodiversity, groundwater protection and establishment of recreation area were selected as different purposes of afforestation. Additionally a contract canceling option, varying sizes of area under monitoring and a compensation payment formed part of the contract. It was suggested to account for heterogeneity among the farmers in order to design contracts efficiently. The studies presented thus far provide evidence that farmers respond differently depending on integral parts of contracts, but also on farm and farmer characteristics including attitudes towards, for example, nature conservation, the use of specific technologies or characteristics of the contractor. Information on farmers' individual preferences is indispensable to design contracts more efficiently and, in turn, achieve a higher level of acceptance. A whole series of studies deals with farmers' preferences in the area of contracting and producers' acceptance of hypothetical production technologies. In fact, there is no study investigating farmers' preferences for programs offered by processors with the objective to produce a specific process quality by employing discrete choice experiments (DCE).

With regard to food products claiming the absence of GMO and animal-friendly production conditions, DCEs were mainly applied to derive consumers' willingness to pay. A cross-cultural survey conducted by Lusk et al. (2003) has shown that some respondents attach value to rib-eye steak produced without GM feed. The data analysis revealed that German consumers were willing to pay \$4.40 per pound more than US consumers. Based on a large-scale survey with 710 Swedish consumers, Carlsson et al. (2005) performed an analysis of preferences for existent as well as non-existent, private and public attributes across six food products. They found that consumers' willingness to pay for animal welfare related attributes vary across products, indicating that their importance seems to be animal specific. Surprisingly high premiums were identified for a ban of GM fodder, for a slower grow chicken breed and outdoor access for pigs and dairy cattle. In a comparable study dealing with animal-friendly pork production, Lagerkvist et al. (2006) estimated Swedish consumers' WTP for specific practices. They reported two interesting results. Firstly, they found that respondents are strongly opposed to fixation of sows and secondly, that allowing pigs to be outdoors is highly valued by consumers. The latter matches the finding of Carlsson et al. (2005). However, consumers prefer pork from surgically castrated boars over pork from intact male pigs. A possible explanation might be that taste quality dominates animal welfare concerns. The authors con-

clude that immuno-castration is a socially accepted alternative to surgical castration. Besides the fact that this treatment causes less pain, it further provides economic advantages due to cost savings and better growth rates compared to surgical castrates. Carlsson et al. (2007) combined a bundle of quality indicators of different meats and asked consumers to choose between various types of chicken fillet and minced beef. The products were described by different attributes: information about product origin and the husbandry system on a label, the type of feedstuff used varying in the content of GMO or the option of GM-feed being entirely banned from the market. Additionally, respondents had to choose between meat from animals that are transported to abattoirs or, alternatively, slaughtered in mobile abattoirs. It turned out that consumers exhibit varying welfare preferences according to animal species. For example, mobile slaughter was found to be negative for broilers, but positively valued for cattle, meaning that, on average, respondents are only willing to pay an increment for mobile slaughter of cattle. Recent work by Liljenstolpe (2008) on consumers' preferences for pig welfare measures like mobile abattoirs, no castration and animal-friendly housing system revealed a high preference for mobile slaughtering and a stock limit of 100 pigs. Previous findings by Lagerkvist et al. (2006) on negative preferences for "no castration" could be confirmed here. Taken together, these results indicate that in spite of consumers' value for enhanced farm animal welfare (FAW), other product quality attributes e.g. taste or impact on health seem to be more important. Moreover, it has to be considered that animal welfare preferences vary regarding the species and food product purchased.

From the previously reviewed studies it appears that DCE are used in various fields to estimate consumers' WTP of product attributes and farmers' acceptance of production schemes, technologies or contracts. Yet, no study exists that examines farmers' acceptance of a GM-free milk production scheme (Chapter 2) and farmers' willingness to participate in a voluntary animal welfare program for dairy cattle (Chapter 3). Furthermore this dissertation contributes to the body of literature by investigating acceptance of animal welfare schemes in pork production bringing together both ends of the value chain, pig production and consumption of pork (Chapter 4). Although work has been done to reveal consumers' preferences for animal-friendly measures in pig farming (e.g. Carlsson et al. 2007; Liljenstolpe 2008), the innovative approach of combining WTP and WTA estimates obtained from identical DCE to simulate a market for high welfare pork has never been used in this context before. A further contribution focusses on farmers' support of a strategic cooperation between dairy companies in milk collection (Chapter 5). The objective of the conducted case studies was to investigate farmers'

preferences for production programs proposed by the private sector to provide a particular process quality employing DCE. Given the topicality of GM-free status of milk as well as FAW in food production, those issues were selected as relevant examples for process qualities. Farmers' decision behavior is often more complex than in cases where profit maximization is the principal driver of decision-making. Therefore the model specifications used latent class (LC) and random parameter logit (RPL) models, allowing for heterogeneity among the population under study. Additionally, attitudinal variables and operational features of farms were incorporated into the analyses to capture and explain behavioral differences. The following chapters have to be considered as distinct contributions and are summarized hereinafter.

Farmers' valuation of incentives to produce GM -free milk: insights from a Discrete Choice Experiment in Germany

The study in Chapter 1 investigates farmers' willingness to participate in a Genetically Modified Organisms (GMO)-free milk production scheme offered by some German dairy companies. The empirical analysis is based upon discrete choice experiments (DCE) with 151 dairy farmers from two regions in Germany. Unlike other studies on farmers' acceptance of production schemes, attributes are selected that are assumed to cause opposite effects: imposed contractual elements requiring additional effort on the one hand, and technical support providing utility on the other. A conditional logit (CL) estimation reveals a strong positive effect of the price premium on offer. Reliable feed monitoring and free technical support increase the likelihood of scheme adoption, the latter however only on farms which have been receiving technical support in other fields. By contrast, any interference with the entrepreneurial autonomy of farmers, be it through pre-arranged feed procurement or prescriptive advice on the part of the dairy company, lowers acceptance probabilities. Farmers' attitudes towards cultivation of GM soy, their assessment of the market potential of GMO-free milk and future feed prices were found to be significant determinants of adoption, as are farmer age, educational status and current feeding regimes. Respondents requested on average a mark-up of 0.80 eurocent per kilogram milk to accept a contract. Comparison of the estimates for the two regions suggests that farmers in northern Germany are, on average, more likely to convert to GM-free production; however, farmers in the south are, *ceteris paribus*, more responsive to an increase in the price premium offered. A latent class model reveals significant differences in the valuation of scheme attributes between two latent classes of "adopters" and "non-adopters". Just over half of the respondents could be classified as potential adopters, whereas the remaining 44% appear to be resistant to the range of incentives on offer. This study derives implications

for dairy companies wishing to introduce a GM-free production scheme to their farmers: intensively communicating their marketing strategy plus a feed monitoring scheme to prevent losses through contamination.

The role of non-use values in dairy farmers' willingness to accept a farm animal welfare program

Discrete choice experiments (DCE) about a hypothetical farm animal welfare (FAW) program were presented to a sample of 78 randomly selected German dairy farmers. Animal-friendly practices like pasturing of dairy cows, higher amounts of space available, somatic cell count limits and additional health checks were included in the choice sets as attributes of the FAW programs. Derived from the theory of social interactions, hypotheses on farmers' adoption behavior deviate from the usual assumption that farmers provide FAW only in accordance with their profit-maximizing objective. Two sets of factors were considered to play a role in the decision-making process: non-use existence values, representing utility farmers may derive from the perceived knowledge that the animal "feels good", and values that are linked with individuals outside the farm household. These include perceived public appreciation of animal welfare as well as the opinion of other farmers about how farm animals should be treated. The ease of implementing program requirements and economic drivers such as increased milk yield and extended productive life-span were assumed to affect the likelihood of program adoption. The analysis of choice data revealed plausible negative effects of program attributes, reflecting rising costs of implementation. Farmers who expect productivity benefits from a program and those, who already take part in a farm quality assurance scheme and regularly exchange opinions on animal welfare are more likely to participate in a FAW program. Splitting farmers into subgroups of program adoption showed that farmers who never accepted a program derive utility from their animals for reasons other than profitability, and at the same time disutility from a FAW program. This underlying aversion against the program *per se* might be explained by perceived loss of autonomy or a lack of familiarity with voluntary programs. Future design of private and public sector FAW programs should therefore consider that farmers' rejection of a program is not necessarily related to their lack of valuing FAW, but may instead indicate the presence of farm-specific transaction costs.

Predicting supply and demand for high-welfare meat with Discrete Choice Experiments

An innovative approach to predict market shares for high-welfare pork is presented in Chapter 4. Based on two DCEs, farmers' willingness to accept (WTA) a FAW program as well as consumers' willingness to pay (WTP) for high-welfare pork were estimated. Respondents faced identical choice sets, except for the monetary variable, representing programs described by varying requirements including minimum barn area for each pig, the use of straw for bedding, access to manipulable material and limitations to the duration of transportation to the abattoir. A random parameter logit (RPL) model revealed that farmers with secured farm succession and those who are selling their meat directly to consumers are more likely to accept a welfare scheme. Comparing actual costs for implementing welfare measures on farm with required compensation payments for the same measures showed that the majority of farmers demand extra compensation. On the other hand, the analysis of consumers' preferences for animal welfare when buying cutlets showed that an increase in product price and transport duration of animals negatively affected the probability of purchase. Consumers who frequently purchase pork from the self-service counter and those who attach more importance to price than to brand, origin or taste of the product and prefer conventional to organic pork are less likely to buy high-welfare pork. Preference estimates enabled calculating carcass prices farmers wish to achieve for compliance with defined program attributes. Additionally, prices that can be paid to farmers were derived from consumers' willingness to pay for high-welfare pork. Market simulations for different scenarios of FAW programs indicate an increasing divergence of supply and demand that arises with increasing strictness of standards. For a FAW program with standards only slightly above the legal minimum standard a market share of 38% was predicted, whereas in a scenario with considerable higher requirements a market balance was not achieved.

Dairy farmers' support of horizontal cooperation among dairy processors: conceptual model and empirical testing

Small dairy cooperatives can improve their economic performance through horizontal cooperation such as joint milk collection from farmers. The approval of such a strategy by cooperative members, however, may be low given the risk of increasing erosion of collective action commitment documented in the literature. The case study in this chapter aims to explain members' decision to approve or disapprove of dairy cooperatives' joint milk collection. A conceptual model was developed based on economic theory but further includes psychological and sociological logics. Farmers' decisions are modeled by means of a discrete choice

experiment. Relevant attitudes and relationship quality are measured using extant scales. The model is then tested on empirical data collected from members of two dairy cooperatives. A multinomial logit (ML) regression is performed to explain farmers' answering patterns, where we distinguish between always supporters, selective deciders, and never supporters. The multinomial logit regression to explain farmers' specific response behavior to the proposed alternative optimization models in the discrete choice experiment reveals that especially the never- and always-supporters can be meaningfully distinguished by their levels of social interaction with other members, supplier relationship quality with the cooperative, and attitude towards the project. Frequent coop member interaction (FCM) and supplier relationship quality (SRQ) are both associated with an increase in the relative-risk ratios of belonging to the group of Never supporters, whereas farmers' attitude towards project and attitudes towards climate change are associated with a decrease in the relative-risk ratios of belonging to that group. Overall, the study hints at the necessity to take into account farmers' attitudes towards proposed strategies, but also their relationship with the cooperative, in order to predict and probably influence their decisions. For the latter, this study provides insights as to the relevance of social interaction among members, which could be exploited in member management.

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Chapter 2

Farmers' valuation of incentives to produce genetically modified organism free milk: Insights from a Discrete Choice Experiment in Germany

Authors

M.Sc. Julia Anette Schreiner and Prof. Dr. Uwe Latacz-Lohmann

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Abstract

This paper investigates farmers' willingness to participate in a Genetically Modified Organisms (GMO)-free milk production scheme offered by some German dairy companies. The empirical analysis is based upon discrete choice experiments (DCE) with 151 dairy farmers from two regions in Germany. A conditional logit (CL) estimation reveals a strong positive effect of the price premium on offer. Reliable feed monitoring and free technical support increase the likelihood of scheme adoption, the latter however only in farms which have been receiving technical support in other fields. By contrast, any interference with the entrepreneurial autonomy of farmers, be it through pre-arranged feed procurement or prescriptive advice on the part of the dairy company, lowers acceptance probabilities. Farmers' attitudes towards cultivation of GM soy, their assessment of the market potential of GMO-free milk and future feed prices were found to be significant determinants of adoption, as are farmer age, educational status and current feeding regimes. Respondents requested on average a mark-up of 0.80 eurocent per kilogram milk to accept a contract. Comparison of the estimates for the two regions suggests that farmers in northern Germany are, on average, more likely to convert to GM-free production; however, farmers in the south are, *ceteris paribus*, more responsive to an increase in the price premium offered. A latent class model reveals significant differences in the valuation of scheme attributes between two latent classes of "adopters" and "non-adopters".

Keywords: GM-free milk production scheme, farmer valuation, discrete choice modelling, latent class analysis

2.1 Introduction

European consumers have been shown to be critical of new technologies such as the use of genetically modified feed or growth hormones in animal husbandry (Lusk et al. 2003; Bredahl 2001; Burton et al. 2001). A comprehensive review of consumers' attitudes towards new food technologies revealed that perceived "naturalness" is highly valued. Moreover, the use of genetically modified organisms (GMO) in food production affects purchasing behavior more adversely than other novel food technologies such as nanotechnologies (Rollin et al. 2011). According to Costa-Font et al. (2008), citizens of Northern European countries and France are less tolerant to GM food than those of the US and southern European countries. In a study among French consumers (n= 97) on willingness to pay (WTP) for food products that differ in their content of GM ingredients, Noussair et al. (2004) found that 35% of respondents are generally unwilling to purchase such products and that a GM-free guarantee raises the WTP for biscuits by 8%. A cross-cultural comparison of consumers' WTP for rib-eye steak confirms that European consumers are more adverse towards the feeding of GM corn than US consumers. For example, the German respondents were willing to pay \$4.40 per pound more than US consumers for a steak produced without GM feed (Lusk et al. 2003). In general, European consumers are willing to accept increasing food bills to obtain products without GMO.

In response to these market developments, some retailers and processors have begun to impose GMO-free requirements on the primary stage of production. In Germany, the production of GM-free milk is one such example which has gained significant importance in recent years, in particular in Bavaria (Dorfner and Uhl 2012). Some dairies, mostly located in the south of Germany, have included this value-added quality concept into their product portfolio. To increase transparency and aid consumers' purchasing decisions, a voluntary GM-free label based on the Law on the Execution of Genetic Engineering (*EG-Gentechnik-Durchführungsgesetz*) was introduced. Farmers who voluntarily accept the requirements for GM-free milk production must prove that they did not use feedstuffs listed as GM feed in EU Regulations 1829/2003 and 1830/2003. Dairy companies wishing to use the label have begun to develop GM-free production schemes in accordance with the Law. These schemes offer a producer price increment to compensate farmers for the additional costs implied by the requirements. The increment varies between 0.5 and 2.0 eurocent per kilogram of raw milk (corresponding to a rise of one to five percent of the milk price) and depends mostly on the marketing success and the type of products sold (Venus and Wesseler 2012).

This paper aims to assess dairy farmer's willingness to participate in a GM-free milk production scheme that a German dairy company is planning to launch. More specifically, we wish to clarify how the production requirements and the incentives offered by the scheme affects farmers' willingness to participate and how much influence farm structure, farmer characteristics, attitudes and region have on adoption behavior. The empirical analysis is based upon discrete choice experiments (DCE) with 151 dairy farmers from two key milk production regions of Germany. Section 2.2 reviews the relevant literature. Section 2.3 describes the experimental setup and the empirical model. The findings are presented and discussed in Section 2.4. The final section summarizes key results and discusses implications for dairy companies wishing to launch comparable schemes.

2.2 Literature Review

Discrete choice experiments (DCE) are mainly applied in fields like marketing and environmental economics to analyze preferences of customers or citizens for certain attributes of consumer goods or environmental assets in hypothetical settings.

A brief overview of studies at the consumer level related to the acceptance of GMO in food (Lusk et al. 2003; Rigby and Burton 2005; Burton et al. 2001) has already been given in the introduction. The following review therefore focuses on relevant studies applying DCE at the producer level. Birol et al. (2008) provide a comprehensive review of the application of DCE in Europe. The studies reviewed are designed to inform the implementation of policies relating to the environment and the agri-food sector. A large number of DCEs have been conducted to investigate farmers' willingness to participate in agri-environmental schemes (AES). Since such schemes are complex and adoption is influenced by many factors (Edwards-Jones 2006), including characteristics of farm and farmers, the DCE method provides information on how schemes can be designed effectively. The valuation of scheme components is reflected by specific willingness to accept estimates which can be calculated by including payment as one of the attributes.

Espinosa-Goded et al. (2010) investigated the factors affecting farmer's willingness to participate in a proposed agri-environmental scheme (AES) paying Spanish farmers to cultivate alfalfa (a nitrogen-fixing crop). Farmer respondents were confronted with choice sets in which they had to choose among alternative contracts, each involving distinct implementation requirements and a given compensation payment. The results indicate that free choice of the land offered for the program and unrestricted use of the alfalfa crop significantly increase

respondents' willingness to sign a contract, as does previous experience with AES participation. Acceptance is also influenced by regional conditions and by farmer and farm-specific characteristics. Significant differences were found in the ranking of attributes between different regions.

Jaeck and Lifran (2013) investigated farmers' willingness to implement agro-ecological practices like weed control and crop rotation in rice production. They applied a latent class model to account for heterogeneity in farm structures and farmer preferences. It was concluded that farmers' concern for environmental issues is a main driver for the implementation of environmentally friendly practices. Birol et al. (2006) used a DCE to investigate Hungarian farmers' preferences for traditional agricultural practices in home gardens, including crop variety diversity, maintaining landraces, integrated crop and livestock production and organic cultivation. They found that the valuation of home garden attributes depends on household structure and regional conditions, such that in regions with a lack of food market access, poorer soils and heterogeneous agro-ecological conditions, home gardens that are rich in crop variety diversity are highly valued. Socio-economic factors such as age and education were also found to affect preferences.

Studies investigating the acceptance of marketing schemes at the producer level are rare. Olynk et al. (2012) conducted a survey among Michigan dairy farmer to estimate the welfare losses when the option to use rbST (recombinant bovine somatotropin) is eliminated from the set of technologies. They designed choice scenarios with varying milk and corn prices, production practices (use of rbST or rbST-free) and different levels of milk production trends. They revealed that farmers, whether using rbST or not, had statistically significant welfare losses from the elimination of this technology. Whereas Olynk et al.'s study dealt with a technology aimed at increasing productivity, the present study focuses on the acceptance of production methods to produce premium milk for a niche market.

Only a small number of studies have investigated the influence of farmers' attitudes towards GM technology in agriculture. Cook and Fairweather (2003), for instance, examined changes in intentions, attitudes and beliefs of farmers regarding the use of GM technology and concluded that attitudes are a key factor for the decision-making process. In particular, producers' concerns about environmental risks, adverse effects on future generations, market acceptance and commercial viability were shown to influence their actions and decision-making related to the cultivation of GM crops. Breustedt et al. (2008) applied a DCE to ex-

plore the adoption behavior of German farmers concerning GM oilseed rape. Besides a strong impact of the gross margin difference between GM and non-GM varieties, they stressed the importance of farm and farmer characteristics for the likelihood of adoption. The attitudes of neighboring farmers towards GM crop cultivation were also found to have an important impact on respondents' willingness to cultivate a GM variety. In a study on farmers' contract acceptance, Schulz (2013, unpublished work) investigated the willingness to fulfill additional contract requirements, including the avoidance of GM feed in dairy farming. The study revealed that the restriction of using only GM-free feed has a smaller negative impact on scheme adoption than the requirement to use only regionally grown feeds. Moreover, farmers who already use oilseed rape as protein component in their rations request less compensation to accept a contract requiring GM-free, regional feeding. The study corroborated the findings of Breustedt et al. (2008) that farmers' attitude toward sustainability and the risks of GM crop cultivation had a significant impact on contract acceptance.

The present paper contributes to this strand of literature by applying a DCE to evaluate farmers' preferences for a GM-free milk production scheme and investigating the valuation of monetary incentives as well as technical support provided by dairy companies. In contrast to the studies cited in this section, we selected scheme attributes that are expected to have opposite effects: imposed contractual requirements that cause additional effort or disutility on the one hand, and technical support offered by dairy companies providing utility on the other.

2.3 The Discrete Choice experiment

Based on interviews with experts in dairy companies and the relevant literature we identified factors that might either hinder or facilitate participation in GM-free production schemes. Based on this information we selected the following attributes for inclusion in the choice sets:

Feed procurement.

The effort and cost of switching the feeding regime depends on the share and composition of concentrate feed in the ration (Dorfner and Uhl (2012), more precisely, on the amount of GM feed to substitute (Venus and Wessler 2012). Farmers can either use GM-free soy or switch their feeding regimes to other protein sources such as oilseed meal or grain legumes without suffering losses in yield performance or milk quality. The price of GM-free soy is around €40 to €80 per metric ton above that of conventional (GM) soy (Dorfner and Uhl 2012). Another important factor for adoption is the availability of GM-free soy on the European market. Soy-

beans for feed are imported to Germany mainly from the U.S., Brazil, Argentina and Paraguay, countries practicing large-scale GM soy cultivation. GM-free feedstuffs are therefore scarce on the European market and thus more expensive (FEFAC 2014). Against this background we chose three alternative specifications for the attribute 'feed procurement':

- Farmer self-procurement (SELF_PROC)
- Dairy company offers a list of regional suppliers of GM-free soy (LIST)
- Dairy company arranges the procurement of feedstuffs (DAIRY_PROC).

Monitoring

Feedstuffs labelled as GM-free are credence goods in that the truth of the GM-free claim cannot be judged prior to purchase (Darby and Karni 1973). Thus contract monitoring is needed to prove compliance with requirements. By including the attribute 'monitoring' in the choice sets we wish to establish which type of monitoring is preferred by farmers. We consider three different monitoring options:

- Farmer self-documentation: the farmer documents all feedstuffs used with delivery notes and a supplier's declaration (DOCU).
- Dairy company audits: the company carries out on-farm audits and carries out laboratory tests to substantiate the GM-free status of feed samples (DAIRY_CONT).
- Independent agency monitoring (Hein et al. 2014): the dairy company entrusts an independent agency with the task to ensure that no GM feed is used (EXT_AUD).

Technical support

Interviews with dairy farmers revealed that lack of know-how to switch the feeding regime or to avoid contamination with GMO is a potential obstacle to adoption. Thus, technical support in the form of advice offered to farmers could turn out to facilitate adoption. We consider three specifications of the attribute:

- free one-off advice offered by the dairy during conversion (DAIRY_ADV);
- free continuous advice by an advisory service (PLUS_ADV);
- no advice offered (NO_ADV).

Price premium

A premium on the producer price of raw milk (PREMIUM) is offered by the dairy company to compensate farmers for the extra cost involved in GM-free milk production. This payment is varied in the range of 0.5 - 1.0 - 1.5 - 2.0 eurocent per kilogram of milk as confirmed to be realistic (Venus and Wessler 2012).

The empirical analysis is based upon discrete choice experiments (DCE) with 151 dairy farmers in two German federal states, Bavaria (in the south) and Schleswig Holstein (in the north). These states represent the two main milk production regions of Germany. Bavaria represents upland and mountainous dairy farming systems with small farms; Schleswig-Holstein represents lowland dairy systems with larger farms size and more favorable natural circumstances. The data were collected in 2013 using a paper-based questionnaire and stratified sampling. Questionnaires were distributed with the aid of a dairy company in Bavaria and the State Inspection Association in Schleswig-Holstein. Of the 800 questionnaires sent out, 151 were returned completed, accounting for a response rate of almost 20 percent. Our sample size is comparable to that of Birol et al. (2006) who interviewed around 100 farmers in three different regions of Hungary. From each choice set (as shown in Table 2.1), respondents were asked to choose the most preferred option: either one of the scheme alternatives or the status quo (no adoption). The 'opt-out' alternative had to be included because participation in GM-free production schemes is voluntary.

The choice sets were compiled by means of SPSS which generated 15 sets of all 108 combinations satisfying a balanced orthogonal and fractional factorial design. The D-efficiency value is 94.9 - sufficiently close to the maximum value of 100 for a perfectly orthogonal and perfectly balanced design (Kuhfeld et al. 1994). In the survey, each farmer was confronted with seven or eight randomly chosen choice sets (Table 2.1). This was done by splitting the 15 choice sets generated by SPSS into two blocks of seven and eight choice sets, respectively. A total of 987 choice sets were included in the estimation. Each choice set contained two GM-free schemes, hence $n = 1974$ scheme alternatives were presented in total.

Table 2.1 Example of a Choice Set

Attributes	Scheme 1	Scheme 2	Opt-Out
Feed procurement	Farmer self-procurement	List of suppliers	Conditions remain unchanged.
Monitoring	Audit by dairy company	External audit	
Technical support	Free one-off advice by the dairy company	Advice plus	
Premium (€cent/kilogram)	2.0	0.5	
I choose:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The Choice Model

The discrete choice method is based on the characteristics theory of value (Lancaster 1966) and the random utility theory provided by Thurstone (1927) and further extended by McFadden (1974) from paired to multiple comparisons. The theory assumes that non-observable variables affect individuals' choices and that utility must be seen as a latent construct with an unexplainable component (McFadden 1974; Manski 1977). In this context, Lancaster stated that utility will be obtained from the attributes of a good rather than from the good itself.

In our model we consider farmers to be utility-maximizing individuals who choose from the alternatives on offer the one with the highest utility. A farmer will therefore only participate in the scheme when the expected utility is higher than the utility obtained from current production. The utility function can be seen as a vector of attributes associated with each choice alternative and a vector of individual farm and farmer characteristics (Ben-Akiva and Lerman 2000). Following the random utility approach, the utility function can be decomposed into two parts: (1) a non-stochastic component which maps the deterministic part of utility dependent on observable attributes of the choice alternative and farm or farmer characteristics; and (2) a stochastic component which reflects the unobserved random variables with zero mean. The deterministic portion of the function is an additive function, i.e. the sum of influences of the attributes and characteristics. In the estimation, the ordinal attribute variables were dummy-type coded and the status quo option was omitted as base level.

The econometric model aims to estimate the probability of a farmer choosing a specific alternative. The function to be estimated is a logistic function ranging from zero to one, depending on the matrix of scheme attributes and the vector of individual farm and farmer characteristics. The impact of scheme attributes and farm/farmer characteristics on choice probabilities

are derived from the estimated parameters of the function. For the estimations it is assumed that the error components are *independently and identically distributed* (IID) following a type-1 extreme value distribution. This condition implies that the variances of the error component of the utilities are identical and the alternatives are independent (Louviere et al. 2000).

After confirming that the *independence of irrelevant alternatives* (IIA) assumption holds applying a Hausman-test, an alternative-specific-conditional logit (ASC) model also known as Mc Fadden's conditional logit was employed (McFadden 1974). The model was estimated using the *asclogit* routine in STATA 12. Based on the estimation results, marginal effects on the likelihood of adoption were computed and used to calculate willingness to accept (WTA). The WTA estimates reflect the price premium requested to compensate farmers for the loss of utility from implementing the production requirements. The marginal effects can be interpreted as the change of the outcome variable (here the likelihood of choice) due to an infinitesimal change of independent variables. For discrete variables it is not appropriate to calculate the marginal effect in terms of infinitesimal changes. Thus, as a preliminary step, the marginal effects were calculated at the sample mean and subsequently a discrete change (from zero to one) of the variable of interest was simulated that leads to a change in the corresponding probability. The difference of both probabilities represents the average marginal effect of the dummy variable or categorical variable (see Breustedt et al. 2008). By setting the marginal effect of an explanatory variable in relation to the marginal effect of the price premium, the WTA for that variable is denoted in monetary terms.

In order to capture the heterogeneity of preferences, interaction terms between scheme attributes and farm/farmer characteristics were included in the model. As explained in Section 2.2, the value placed on the attributes is strongly related to individual resource settings and current production practices. For example, support to procure GM-free feed may be valued differently by different farmers depending on whether they are already feeding non-GM protein components. Additionally, provision of advice might be more important to farmers who have previously accepted advice on other matters and are more receptive towards agricultural advice in general. Thus, the first and the second interaction terms are products of the attributes "DAIRY_PROC" and "LIST" with the variable "SEG", a variable indicating the use of soy extraction grist in the current feeding regime. The third and fourth interaction term were created as product of the attributes "DAIRY_ADV" and "PLUS_ADV" and the variable "ADV", which indicates farmers receiving technical assistance in other fields.

In addition to the CL model, a latent class (LC) model was estimated allowing parameter estimates to vary among distinguishable latent classes where the preferences are homogeneous within but differ substantially across the classes. In contrast to the mixed logit model, the distribution of coefficients is discrete, with the parameter estimates taking distinct values (Train 2003). To assess farmers' willingness to adopt GM-free production, investigation of preferences among different groups and hence application of an LC model is most suitable (Birol et al. 2011). Farmers are assigned to latent groups according to their individual characteristics, attitudes and the farm properties. The LC analysis is based on the STATA estimation command *lologit* by Pacifico and Yoo (2012).

2.4 Results

Descriptive statistics

Table 2.2 presents the descriptive statistics of the whole sample (N = 151). The average age of respondents is 44 years; 87% are farm managers (owner operators), thus the decision-makers on the farm. Over half of the respondents have vocational qualifications or a college or university degree (High Edu) and 90% of all farmers achieved their qualification in the field of agriculture. The majority of farms are pure agricultural enterprises. A few of them also have photovoltaic systems. The share of feeding soy extraction grist (SEG) within the sample is considerable (almost 80%). The attitudinal variables indicate that, on average, respondents believe that GM soy cultivation has a negative impact on biodiversity. Respondents' assessment of consumer demand for GM-free milk is rather neutral on average. Concerning feed prices for conventional soy and oilseed rape, they expect, on average, rather unstable and increasing prices in the future.

Table 2.2 Summary statistics of respondents

Whole sample N = 151

Variable	Mean (SD)	Explanation
Age	44.2 (8.6)	Age of participant (years)
Farm Acr	100.39 (65.8)	Farm acreage (total in hectares)
Grassland	43.8 (28.2)	Grassland (total in hectares)
Forage Prod (N = 57)	17.44 (20.59)	Forage production (total in hectares of arable land)
Corn Sil (N = 127)	30.05 (40.84)	Production of corn for silage (total in hectares)
Herd size	86 (65)	Herd size (number of cows)
Milk yield	7188.8 (1431.3)	Milk yield in kilograms per cow and year
Income Milk	66.65 (21.17)	Share of farm income from milk production
Dummy variables (1 = yes)	Proportion of affirmative response (%)	Explanation
Farm manager	86.99	Respondent is farm manager
Young	14.21	Farm manager is under 35 years
Successor	46.58	Farmer has a successor
High Edu	52.05	Farmer with vocational training, degree from a technical college or university degree
ADV	68.75	Farm uses advisory services
Agri-branch	44.52	Farm is solely an agricultural enterprise
SEG	79.45	Farmer is feeding soy extraction grist (SEG)
Conc_Purch	58.90	100% of concentrates purchased
Categorical Variables	Mean (SD)	Explanation
Negative impact of GMO	2.5 (0.98)	Item: "The cultivation of GM-soy has a negative impact on biodiversity in the producing countries." (1 = I fully agree; 5 = I fully disagree)
Assessment of consumers' WTP	3.02 (1.03)	Item: "Consumers have a higher willingness to pay for GM-free milk." (1 = I fully agree; 5 = I fully disagree)
GM-free milk = short lived trend	2.92 (0.97)	Item: "GM-free milk is a short-lived trend." (1 = I fully agree; 5 = I fully disagree)
Feed price volatility	3.7 (0.94)	Expectation of volatility of feed prices (soy and oilseed rape) compared to the current year. (1 = prices will be very stable; 5 = prices will be very unstable)
Feed price development	3.91 (0.97)	Expectation of long-term (10 years) feed price development (soy and oilseed rape) (1 = prices will be decreasing; 5 = prices will be increasing)

Notable differences were found between the two study regions (Table 2.3). Average farm size and the share of permanent grassland are twice as high in Schleswig-Holstein as in Bavaria. The same holds for herd size. The share of land used for arable forage production is slightly higher in Schleswig-Holstein. The share of farmers feeding SEG and buying fodder mixture is also higher in Schleswig-Holstein, indicating a stronger reliance on the animal feed market.

Table 2.3 Descriptive statistics of respondents by region

	Bavaria (N = 57)	Schleswig-Holstein (N = 94)
Variable	Mean (SD)	Mean (SD)
Age	45.4 (8.48)	43.48 (10.0)
Farm Acr	58.23 (28.05)	124.81 (69.07)
Grassland	24.57 (12.66) (N = 51)	56.21 (27.86) (N = 89)
Forage Prod	4.55 (6.17) (N = 19)	23.89 (22.25) (N = 38)
Corn Sil	10.9 (6.58) (N = 48)	35.79 (46.13) (N = 79)
Herd size	37.4 (23.8)	68.7 (56.7)
Milk yield	6240.539 (1186.306)	7726.26 (1274.60)
Income Milk	63.33 (17.72)	68.48 (22.74)
Dummy variables (1= yes)	Proportion of affirmative response (%)	Proportion of affirmative response (%)
Farm manager	89.09	85.71
Young	11.61	15.71
Successor	47.27	46.15
High Edu	47.14	54.94
ADV	66.03	70.32
Agri-branch	39.53	61.22
SEG	67.27	86.81
Conc_Purch	10.90	87.91
Negative impact of GMO	2.34 (1.00)	2.59 (0.96)
Estimation of consumers' WTP	2.75 (1.00)	3.17 (1.02)
GM-free milk = short lived trend	3.13 (0.99)	2.8 (0.95)
Feed price volatility	3.72 (0.91)	3.75 (0.95)
Feed price development	4.01 (0.91)	3.85 (0.99)

Only minor differences regarding the attitudinal variables were found between the samples. Respondent' attitude towards GMO is on average rather negative, and farmers from both regions expect increasing and more volatile prices of conventional soy and oilseed rape in the future. Farmers have rather neutral views on consumers' willingness to pay for GM-free milk and the statement that GM-free milk is a short-lived trend.

Estimation results

We begin by presenting the results of the conditional logit (CL) model. First, the estimation was conducted for the whole sample, then for subsets by region. Subsequently, marginal effects on the likelihood of adoption and also the respective compensation payment (WTA) in eurocent per kilogram milk were calculated for each explanatory variable. Table 2.4 reports the estimation results for the whole sample. Tables 2.5 and 2.6 show the marginal effects and compensation prices for the whole sample and differentiated by region, respectively. The full model includes all exogenous variables. To improve model fit only variables significant at the 10% level or below were included in the estimation of a parsimonious model (see right-hand column of Table 2.4). Following a likelihood ratio test (χ^2 -value = 4.37; Prob > χ^2 = 0.9292) eight insignificant variables were omitted from the model without impairing the model fit. Additionally, a robust Wald test (χ^2 -value = 2.65 with $\alpha = 0.9151$) confirmed the hypothesis that the coefficients of the omitted variables are zero. The McFadden pseudo R² of the parsimonious model is 0.208 which indicates an extremely good model fit according to Louviere et al. (2000).

From the 987 decisions, 53.2% were in favor of conversion to GM-free milk production. Out of all 151 farmers, 35 (23.2%) always chose the GM-free scheme. By contrast, 34 respondents (22.5%) never chose a scheme option. From the farmers who always chose the scheme, 23 are located in Schleswig-Holstein and 12 in Bavaria. From those who have never accepted a scheme, 24 are located in Schleswig-Holstein and 10 in Bavaria. The overall probability that a GM-free alternative is accepted is 0.48 (Bavarian farmers 0.47 and for farmers from Schleswig-Holstein 0.48). On average, respondents requested a mark-up of 0.80 eurocent per kilogram milk to accept a contract. Among the scheme attribute variables, the price premium has the greatest influence on adoption. The attributes "DAIRY_PROC", "EXT_AUD" and all levels of technical support including "NO_ADV" exert an adverse effect on scheme adoption. Referring to Key (2005), farmers' preferences for independence from the dairy company may be a plausible explanation for rejecting attributes which would confine autonomy. An audit by an external certifier (EXT_AUD) is often time-consuming and related to high effort on the part of farmers. By contrast, "DAIRY_CONT" has a positive influence on the probability of adoption, indicating that the monitoring of feedstuff (including laboratory testing) by the dairy company is valued by farmers – presumably as a protection against potential losses of mark-ups. Among the four interaction terms, the ones between the advice attributes and farms which have been receiving advice in other fields are significant. The positive coefficient indi-

cates that farmers who have previously accepted agricultural advice in other cases are more inclined to adopt a GM-free contract when free advice is offered.

In addition to the provisions of the production scheme, farm and farmer characteristics have an impact on the likelihood of adoption. Farmers under 35 are less likely to participate. Regarding a longer planning horizon, younger farmers may rather be interested in investing in productivity-enhancing technologies than niche production. Higher educational achievement (vocational training, degree from technical college or university) lowers the acceptance of GM-free production. In the literature, the effect of education on the adoption of new technologies is often discussed and there is no scientific agreement on the direction of impact (Knowler and Bradshaw 2007; Prokopy et al. 2008). GM-free milk production can be seen as a management-intensive technology that does not necessarily require higher education or better knowledge. Such a scheme is rather feasible for less specialized farms (Dorfner and Uhl 2012).

Region (0 = Bavaria; 1 = Schleswig-Holstein) and herd size have a significant and positive effect on the likelihood of adoption, implying that farmers with larger farms and those in the lowland regions of northern Germany are more inclined to participate. The share of grassland and land used for cultivation of corn silage, the feeding of soy extraction grist (SEG) and complete purchasing of concentrate lower the probability of adoption. The availability of grassland and land grown with corn is not necessarily related to the diet of dairy cows in that the biomass may be used to feed anaerobic digesters. The negative effects of feeding SEG and the purchase of concentrates are plausible because farms which strongly rely on the feed market are likely to face higher switching costs. Of the five attitudinal variables, four have an impact on the probability of adoption. As expected, farmers with a negative attitude towards cultivation of GM soy and those who are convinced of existing consumer demand for GM-free milk are more likely to adopt a GM-free scheme. Expectations of stable and, in the long-run, decreasing prices for GM soy and oilseed rape lower the likelihood of scheme adoption.

Table 2.4 Estimation results of the CL model

N= 151		Full model	Parsimonious model
Log-Likelihood		-831.796	-836.557
		Coefficient (SD)	Coefficient (SD)
Production Scheme Attributes x	PREMIUM	1.165*** (0.120)	1.176*** (0.112)
	SELF_PROC	-0.125 (0.499)	-
	DAIRY_PROC	-0.908* (0.571)	-0.846*** (0.136)
	LIST	-0.018 (0.528)	-
	DOCU	-0.036 (0.141)	-
	EXT_AUD	-0.548** (0.164)	-0.496*** (0.135)
	DAIRY_CONT	0.242* (0.192)	0.249** (0.148)
	NO_ADV	-1.432** (0.676)	-1.337*** (0.336)
	DAIRY_ADV	-1.565** (0.703)	-1.494*** (0.370)
	PLUS_ADV	-1.590** (0.717)	-1.525*** (0.363)
Interaction terms x*z	DAIRY_ADV* ADV	0.451** (0.260)	0.488** (0.254)
	PLUS_ADV* ADV	0.466** (0.253)	0.499** (0.248)
	DAIRY_PROC*SEG	-0.042 (0.343)	-
	LIST*SEG	0.005 (0.305)	-
Socio-economic variables and farm characteristics z	Young	-0.559** (0.205)	-0.544** (0.200)
	High Edu	-0.574*** (0.156)	-0.545** (0.155)
	Successor	-0.080 (0.157)	-
	Income Milk	0.004 (0.004)	-
	Grassland	-0.017*** (0.005)	-0.015** (0.004)
	Region	1.588*** (0.304)	1.533*** (0.288)
	Herd size	0.016** (0.008)	0.007*** (0.002)
	Forage Prod	-0.025*** (0.007)	-0.025*** (0.007)
	Corn Sil	-0.008** (0.003)	-0.010** (0.003)
	SEG	-0.777** (0.267)	-0.772** (0.212)
	Conc_Purch	-1.108*** (0.260)	-1.107*** (0.252)
Attitudinal variables z	Negative impact of GMO soy	1.001*** (0.160)	1.013*** (0.150)
	Consumers' WTP is positive	0.628** (0.193)	0.656*** (0.189)
	GM-free milk = short lived trend	-0.005 (0.184)	-
	Expectation of stable prices (soy and rapeseed)	-0.595** (0.227)	-0.569** (0.227)
	Expectation of decreasing prices (soy and rapeseed oil)	-0.663** (0.276)	-0.607** (0.266)

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

Table 2.5 shows the marginal effects of the attributes and the corresponding WTA estimates based on the parsimonious model. An increase in the price premium by one eurocent per kilogram of milk raises the likelihood of adoption by 29 percentage points. Surprisingly, farmers don't like the idea of the dairy company organizing the purchasing of GM-free protein feed on their behalf ("DAIRY_PROC"): this option lowers the acceptance probability by 20 percentage points, and a milk price increment of 0.69 eurocent per kilogram is required to offset this effect. The negative marginal effects for the audit options and technical support measures highlight the respondents' refusal of any form of external intervention. Prescribing audits by an external organization requires a price increment of around 0.42 eurocent per kilogram milk. Free one-off advice from the dairy company during the conversion period ("DAIRY_ADV") requires a mark-up of 1.11 eurocent; more frequent advice ("PLUS_ADV"), which includes technical assistance on feeding regimes and separation of production lines, is even more expensive (1.12 eurocent per kilogram), although the service would be offered for free. There are, however, large differences in respondents' receptiveness to technical support: farmers who already take advice assign a positive value to the service. The coefficient of the two interaction terms show that for those farmers the mark-up can be lowered by around 0.40 eurocent per kilogram milk if free advice is provided.

Socio-economic and farm variables also impact the likelihood of adoption. Younger farmers (below 35) and better educated farmers (with vocational training or degree) request on average higher mark-ups than older and less well trained colleagues. A first hint at regional differences is given by the highly significant coefficient of the "region" variable. A discrete change from zero (Bavaria) to one (Schleswig-Holstein) raises the probability of acceptance by 36 percentage points and lowers the mark-up on the milk price by 1.22 eurocent. The marginal effect of "herd size" is positive but quite low, as are the negative effects of the feeding variables "Forage Prod" and "Corn Sil". An increase in herd size by ten cows would raise the acceptance probability by 2 percentage points. For farmers who find it difficult to convert to GM-free production due to a high share of SEG request an extra 0.65 eurocent per kilogram.

The attitudinal variables have a notable impact on adoption behavior: farmers who are strongly concerned about the impact of GM soy cultivation request 0.84 eurocent less price premium. Farmers who believe that prices of soy and oilseed will rise require 0.47 eurocent more. Likewise, respondents who are critical of the market success of GM-free milk request a premium of 0.55 eurocent.

Table 2.5 Marginal effects on the probability of adoption for whole sample

Parsimonious estimation
N = 151

	Variables	Marginal effect	WTA[€/cent/kilogram] confidence interval (2.5%; 97.5%)
Production Scheme Attributes x	PREMIUM (change +1 ct/kilogram)	0.294***	-
	DAIRY_PROC	-0.203***	0.691 (0.422; 0.959)
	DAIRY_CONT	0.062**	-0.210 (-0.458; -0.038)
	EXT_AUD	-0.123***	0.417 (0.182; 0.653)
	NO_ADV	-0.298***	1.017 (0.524; 1.510)
	DAIRY_ADV	-0.324***	1.105 (0.545; 1.665)
	PLUS_ADV	-0.329***	1.122 (0.573; 1.670)
	DAIRY_ADV x advised farms	0.118**	-0.403 (-0.832; 0,026)
	PLUS_ADV x advised farms	0.121**	-0.412 (-0.830; 0,007)
	Socio-economic variables and farm characteristics z	Young	-0.133**
High Edu		-0.135***	0.461 (0.92; 0.729)
Grassland		-0.004***	0.013 (0.005; 0.020)
Region		0.358***	-1.220 (-1.749; -0.691)
Herd size		0.002***	-0.006 (-0.108; 0.095)
Forage Prod		-0.006***	0.021 (0.009; 0.032)
Corn Sil		-0.003**	0.009 (-0.157; 0.174)
Feeding SEG		-0.189***	0.645 (0.276; 1.013)
Conc_Purch		-0.270***	0.919 (0.463; 1.375)
Attitudinal variables z		Negative impact of GMO***	0.248***
	Expectation of stable prices (soy and oilseed rape)**	-0.147*	0.471 (0.086; 0.851)
	Expectation of decreasing prices (soy and oilseed rape)**	-0.138**	0.500 (0.045; 0.955)
	Consumers' WTP is positive***	0.162***	-0.553 (-0.882; -0.223)

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

To account for regional effects, marginal effects and WTA estimates have been derived for the subsets of farmers in Bavaria and Schleswig-Holstein (Table 2.6). It is clear from the table that the Bavarian farmers are more responsive to changes in the premium. An increase by one eurocent per kilogram milk raises the probability of adoption by 46 percentage points among the Bavarian respondents and by only 26 percentage points among farmers from Schleswig-Holstein. Marked differences also exist with respect to feed procurement. Farmer self-procurement has a negative impact on adoption and leads to a higher compensation requirement (+0.83 eurocent) in the Bavarian sample, whereas the option is valued positively by Schleswig-Holstein farmers (mark-up lowered by 0.49 eurocent). An opposing effect was also found for the provision of a list of suppliers for GM-free feed. This type of support decreases the likelihood of acceptance in the Bavarian sample but increases it in the sample from Schleswig-Holstein. If the dairy company demands external audits by a certifier agency, this must be "bought" at a price of 0.43 eurocent from the Bavarian farmers, whereas the variable is not significant in the Schleswig-Holstein sample. Feed monitoring offered by the dairy company is valued positively in both samples, lowering the necessary mark-up by 0.32 eurocent in the Bavarian sample and by 0.55 eurocent among farmers from Northern Germany.

Regional differences are also detected for the effects of socio-economic variables. Better educated farmers from Bavaria require a price increment of 1.09 eurocent compared to only 0.41 eurocent for farmers from Schleswig-Holstein. A high share of SEG in the ration is only significant in the Bavarian sample.

The attitudinal variables have the same sign in both samples. The magnitude of the effects is also similar except for farmers' expectations of decreasing prices for GM soy and oilseed rape, which lower the adoption probability in Schleswig-Holstein but are not significant in Bavaria. Farmers who are critical of GM soy cultivation request less compensation. In the Bavarian sample the required premium is about two times lower than that for Schleswig-Holstein.

Table 2.6 Marginal effects on the probability of adoption by region

Parsimonious estimation N = 151		Bavaria (N = 57)		Schleswig-Holstein (N = 94)	
Variables	Marginal effect	WTA [€cent/kilogram] confidence interval (2.5%; 97.5%)	Marginal effect	WTA [€cent/kilogram] confidence interval (2.5%; 97.5%)	
Production Scheme Attributes x	PREMIUM	0.459***	-	0.258***	-
	SELF_PROC	-0.381***	0.831 (0.133; 1.795)	0.126**	-0.489 (-0.823; -0.154)
	DAIRY_PROC	-0.472***	1.028 (0.247; 1.810)	-	-
	LIST	-0.392***	0.854 (0.072; 1.636)	0.272***	-1.056 (-1.753; -0.358)
	DOCU	-	-	0.085*	-0.330 (-0.688; 0.028)
	DAIRY_CONT	0.145**	-0.317 (-0.636; 0.002)	0.142**	-0.549 (-0.942; -0.157)
	EXT_AUD	-0.198***	0.431 (0.135; 0.727)	-	-
Socio-economic variables and farm characteristics z	Young	-0.253**	0.550 (-0.020; 1.120)	-0.128**	0.497 (-1.237; 2.231)
	High Edu	-0.500***	1.088 (0.585; 1.592)	-0.105**	0.408 (-1.114; 1.931)
	Grassland	-0.010**	0.022 (0.005; 0.039)	-0.004**	0.014 (-0.021; 0.049)
	Feeding SEG	-0.387***	0.843 (0.368; 1.318)	-	-
	Conc_Purch	-	-	0.424***	1.641 (-0.450; 3.733)
Attitudinal variables z	Negative impact of GMO	0.193***	-0.421 (-0.839; -0.002)	0.229***	-0.886 (-2.344; 0.572)
	Expectation of stable prices	0.362***	-0.788 (-1.345; -0.231)	0.342***	-1.122 (-1.562; -0.683)
	Expectation of decreasing prices	-	-	-0.266**	1.032 (-1.432; 3.496)
	Consumers' WTP is positive	0.412***	-0.898 (-1.286; -0.510)	0.246***	-0.955 (-2.834; 0.924)

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

Latent Class estimation

To account for heterogeneous preferences among respondents we estimated a latent class (LC) model which allows parameter estimates to vary among different classes of respondents (Train 2003). The LC assumes a finite number of latent structures underlying the data and classifies the sample into groups taking the estimated class membership for each farmer into account. The optimal number of classes is determined *ex ante*, based on goodness of fit measures (Train 2008). For the model with seven attributes and eleven membership variables, two classes revealed the best data fit. Table 2.7 presents the results.

Table 2.7 Results from the LC estimation

Variables	Class 1 "Non-adopters" 43.8%	Class 2 "Adopters" 56.2%
	WTA[€/cent/kilogram] confidence interval (2.5%; 97.5%)	WTA[€/cent/kilogram] confidence interval (2.5%; 97.5%)
DAIRY_PROC	0.444* (-0.074; 0.961)	0.778*** (0.450; 1.107)
DAIRY_CONTR	-0.336* (-0.815; 0.144)	-0.273* (-0.618; 0.073)
EXT_AUD	0.181 (0.771; 0.802)	0.537*** (0.264; 0.809)
NO_ADV	2.709*** (2.221; 3.196)	0.136 (-0.371; 0.643)
DAIRY_ADV	2.749*** (2.178; 3.321)	0.793 (0.414; 1.173)
PLUS_ADV	2.969*** (2.270; 3.668)	-0,021* (-0.486; 0.444)

Levels of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The average membership probability of class 1 is 43.8% and that of class 2 is 56.2%. The average probability of accepting the GM-free production scheme for farmers in class 2 is 43% and in class 1 only 4.9%. We thus term class 2 members "adopters" and members of class 1 "non-adopters". As can be seen from the WTA estimates, the "non-adopters" request prohibitively high compensation for accepting technical assistance in the form of advice. The corresponding variables for the "adopters" are not significant, except for the "ADV_PLUS" variable, indicating that those who, in principle, are willing to convert are also receptive to accept technical assistance. As one would expect from the estimation results in Table 2.6, farmers

from Bavaria are more likely to be members of the class of “non-adopters”. Moreover, farmers with a less negative attitude towards cultivation of GM soy and those who are less convinced of existing consumer demand are more likely to be in the class of “non-adopters”. A comparison of the latent class estimation results and the calculated WTA from the conditional logit (CL) models reveals similarities – evidence for the robustness of results.

2.5 Discussion and Conclusion

This paper set out to investigate farmers' willingness to accept a GM-free milk production scheme. Similar schemes are being launched by a number of German dairy companies in response to increasing consumer demand for milk produced without GM feeds. A DCE was carried out to explore dairy farmers' likely responses to alternative contractual requirements and incentives. The empirical analysis covered the two main milk production regions of Germany: Bavaria in the south and Schleswig-Holstein in the north.

Our findings are largely consistent with those of Schulz (2013, unpublished work) who investigated dairy farmers' acceptance of contract requirements including a ban on GM feed. They calculated a compensation price of 0.77 eurocent for banning GM feed from dairy cow rations. Our analysis yielded an estimate of 0.80 eurocent on average. Our estimates of the necessary mark-up for farms feeding soy extraction grist also accord with those of Schulz (2013, unpublished work): 0.65 eurocent in our study and 0.65 eurocent in Schulz.

The findings of the present study reveal a potential willingness to adopt GM-free milk production among dairy farmers. This is slightly higher in the northern part of Germany with its favorable farm structures and natural circumstances. The latent class estimations, however, revealed large differences in farmers' preferences. Just over half of the respondents were classified as potential “adopters”, willing to consider trade-offs between stricter production requirements and higher price premiums. The remaining 44 per cent appear to be resistant to the range of incentives offered in the experiment.

Besides the price premium on offer, monitoring of feed samples and free advice are positively valued by potential adopters. Offering reliable feedstuff monitoring to assure that the feed is actually free from GMO is thus likely to be an effective means for dairy companies of enticing farmers into GM-free production schemes. Also, dairy companies are well advised to target farmers who have been receiving technical advice in other fields: such farmers are more receptive to scheme-specific technical assistance and, as a consequence, request lower price premiums when free technical advice is offered. However, any interference with the entrepre-

neurial autonomy of the farmer, be it through pre-arranged feed procurement or prescriptive advice on the part of the dairy company, lowers the acceptance of the scheme – a finding in agreement with Key (2005) who stresses farmers' preference for autonomy.

Although no obvious conclusions can be drawn from the variables representing current feeding regimes, the estimation results confirm that farmers who are more reliant on external feeds are less likely to adopt GM-free production. This study has also highlighted the role of “soft” factors: farmers' attitudes towards GM soy cultivation, their assessment of consumer demand for GM-free milk and expectations of future concentrate feed prices all have a strong impact on adoption. Dairy companies wishing to launch GM-free production schemes should thus focus on intensive communication of their marketing strategy as a means of encouraging farmer collaboration. Comparison of the estimates for the two regions suggests that dairy farmers in northern Germany are, on average, more likely to convert to GM-free production; however, farmers in Bavaria are *ceteris paribus* more responsive to an increase in the price premium offered. With the exception of feed monitoring, all other attributes of technical support turned out to lower adoption probabilities, indicating a strong preference for monetary incentives among respondents.

While this paper offers first insights into likely responses of dairy farmers to alternative production requirements and financial incentives, more research is needed to derive more comprehensive conclusions. Non-monetary motives and socio-economic factors such as communication and interaction among farmers in social networks are likely to affect adoption behavior as shown by Läßle and Kelley (2015) for the adoption of organic farming. We leave this for future research.

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Chapter 3

The role of non-use values in dairy farmers' willingness to accept a farm animal welfare program

Authors

M.Sc. Julia Anette Schreiner and Prof. Dr. Sebastian Hess

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Abstract

Choice experiments about a hypothetical farm animal welfare (FAW) program were presented to a sample of randomly selected German dairy farmers. Based on the theory of social interactions, it was hypothesized that the probability of participating in the program would increase with i) the ease of implementing program attributes on the farm, ii) perceived use values such as increased milk yield, and iii) stated levels of non-use existence values derived from improved animal welfare conditions and extrinsically motivated non-use values from enhanced prestige among relevant peer groups. It was found that non-use existence values were negatively related to program acceptance because relatively high personal standards may not be in line with the program design and may make the program seem unnecessary. In addition, the intention of enhancing public acceptance of dairy farming appeared to have an influence on some farmers' willingness to accept the program, which can be explained by the relevance of social interactions among peers in the context of farmers' provision of FAW.

Keywords: farm animal welfare, choice experiments, random parameter logit model, non-use values, social interactions

JEL classification: Q12, Q18, Q19, C49

3.1 Introduction

It is commonly assumed that farmers raise farm animals in order to maximize profits. Lusk and Norwood (2011) argue in this context that profit-maximizing choices of input and output levels are most likely different from the corresponding levels that would maximize farm animal welfare. Furthermore, larger and more professional farms are widely believed to provide *ceteris paribus* lower levels of farm animal welfare (FAW) than smaller and more traditional farms because economic optimization would not leave room for ethical or other potential non-monetary values related to how animals are treated (Fraser 2005; Burton et al. 2012).

While questions of consumers' willingness to pay for FAW (Lagerkvist and Hess 2011) and related public and private policy issues (Ingenbleek et al. 2012) are attracting increasing attention within the scientific literature, only a limited set of studies has begun to analyze the role that farmers' personal evaluations of FAW may play here: it is commonly assumed that the provision of FAW is subject to a farmer's profit-maximizing objective. However, little is known about how the decision to provide FAW may enter a farmer's utility function (Lagerkvist et al. 2011). Austin et al. (2005) aimed to shed light on the link between a farmer's personality and attitude and the implementation of good welfare practices. They developed a welfare attitude scale to measure farmers' attitudes towards animal welfare and tested it empirically with both farmers and agriculture students. From this they identify two superordinate dimensions in the two groups: welfare and business orientation. Bock and van Huik (2007) investigated pig farmers' acceptance of different types of animal welfare schemes and identify two groups of farmers: one group describing animal welfare mainly in terms of health and considering it important for economic outcomes, and another group of farmers that relates animal welfare to the possibility of expressing natural behavior. Bock and van Huik (2007) report that the latter group views the enhancement of animals' wellbeing as a moral obligation. Members of the second group participate in specific FAW schemes or organic farming and are in favor of stricter regulations in future. Bock and van Huik (2007) conclude that farmers' attitudes towards FAW are neither a result of ethical concern nor driven by compassion for animals alone, but have to be seen in the broader context of their farms' business objectives. Vanhonacker et al. (2008) find a heterogeneous set of farmers' interests influencing their perceptions of FAW: while some are more economically driven, others are, in addition to their profit-maximizing objectives, also interested in supplying high quality products, having a satisfying job and establishing a more positive image of their profession among the public.

McInerney (2004) proposes that economic analyses of FAW provision should consider not only productivity-related use values, but non-use values as well. Lagerkvist et al. (2011) identify in this respect key elements that determine farmers' preferences for use and non-use values related to FAW, emphasizing the importance of taking into account the trade-off between use and non-use values when explaining the level of FAW provided by farmers. Based on the theory of planned behavior, they hypothesize that producers' beliefs concerning the attributes associated with FAW govern their decision-making, aiming to maximize their utility. From this perspective, higher levels of FAW may result in improved productivity and the better health status of animals, thereby affecting costs of production. However, Lagerkvist et al. (2011) do not provide an empirical test for their conceptual framework in which FAW-related non-use values enter the simultaneous production and consumption decision of a household production framework. Hansson and Lagerkvist (2015) conducted in-depth qualitative interviews with Swedish dairy farmers. The element "animals feel good" is mentioned 228 times and thus is by far the most commonly used element, together with identified values such as "avoidance of suffering", "continue business", "ethics", "doing the right thing", "animals eating properly", and "work environment", which the authors relate to "existence non-use values". In addition, they find the elements "impression on others" and "product quality" to be representations of paternalistic-altruism-related non-use values (terminology as in Lagerkvist et al. 2011).

The aim of the present paper was to undertake further analysis of the potential role of non-use values in farmers' decisions to provide FAW and, more formally, use a discrete choice experiment (DCE) about the decision to adopt a voluntary FAW program in dairy farming.

The DCE method is well suited to determining and quantifying factors that may influence farmers' willingness to accept (WTA) a certain FAW standard, represented by the hypothetical program described by a bundle of requirements. In addition, the study had a practical policy implication because several European dairy companies have recently begun to work towards implementing private sector FAW program that would go beyond the basic legal regulations concerning animal protection. These dairy companies are interested in implementing animal welfare schemes and rewarding those milk suppliers who comply by means of a compensatory premium on milk price.

Section 3.2 establishes a conceptual framework based on the theory of social interactions. It is argued that this theory based on a household production model is more appropriate for gener-

ating empirically testable hypotheses than the household production framework outlined in Lagerkvist et al. (2011). It is then demonstrated how the hypotheses derived from the general theoretical framework could be tested using a discrete choice experiment (DCE). Section 3.3 then presents the empirical implementation based on a sample of German dairy farmers. Section 3.4 presents the data and estimation results from a random parameter (RPL) logit model and Section 3.5 discusses key findings and finally concludes with a perspective on future research and policy recommendations.

3.2 Conceptual framework

Integrating production decisions and non-use values

The theory of social interactions (Becker 1974) is a widely-used household production framework that, to the authors' knowledge, has never before been applied to farmers' choices of a FAW program. The theoretical framework is based on the farm household's (i) utility function $U_i = U_i(Z_1, \dots, Z_m)$, in which utility is a function of the consumption of different goods Z . These goods are partly produced by the household itself, for instance a farm household may produce milk output Z_{Milk} using dairy cows and other marketable inputs (summarized in the milk-specific vector X_{Milk}), according to the following farm i -specific production function:

$$(3.1) \quad Z_{Milk}^i = f^i(X_{Milk}, t_{Milk}^i; E^i, R_{Milk}^1, \dots, R_{Milk}^r)$$

Equation 3.1 says that farm household i will produce its milk output according to marketable inputs X_{Milk} and its available time t . Becker (1974) shows how time used in the production process of one output such as milk has to be valued against its household specific opportunity cost, for example from working off-farm or from the consumption of leisure time. Furthermore, following Becker (1974), it was assumed here that this production process is governed by two further vectors that cannot be treated as fully exogenous to the decision-making process: vector E is commonly used to describe "environmental variables" such as education, religion or other characteristics that may influence the way in which X and t are combined to produce Z^2 . In the context of FAW, following the terminology proposed by Lagerkvist et al. (2011), E is interpreted as a vector of farm household-specific non-use existence values. Such values may refer to the farmers' utility derived from their evaluation associated with the per-

² Within the framework of stochastic frontier-based analysis of the technical efficiency of production processes, such environmental variables are typically modelled as shifting the level of technical inefficiency.

ceived knowledge that the “animal feels good” (Hansson and Lagerkvist 2015). Different levels of E among different farm households may lead to different choices of inputs X and t , such that different output levels are achieved. Thus when substituting Z in the utility function by the different production processes, such as the one outlined in equation 3.1, it becomes evident that the level of E affects utility directly, but also indirectly through its effect on marketable milk output Z_{Milk} .

While the level of the existence non-use values E is assumed here to be a static factor affecting production technology, Becker (1974) explains that the role of the variables R_{Milk}^r is more subtle: these variables describe the characteristics of other persons outside the farm household, and their characteristics may affect the choice of output level Z_{Milk} . This happens through the assumption that household i can partly influence these characteristics through their own effort h (= forgone income) such that

$$(3.2) \quad R_{Milk}^r = D_i^r + h_i$$

Equation 3.2 breaks down the characteristics of other members of the society into an exogenous part D_i^r , e.g. the existing level of public appreciation of the farm household's state of FAW, or the existing level of knowledge and opinion that other farmers (or members of the administration who check FAW compliance for example) who form a relevant peer group for household i may have. In the terminology proposed by Lagerkvist et al. (2011), R_{Milk}^r is interpreted as the representation of non-use values related to paternalistic altruism (e.g. household i 's utility derived from the opinion that others express about FAW at farm i).

Becker (1974) provides further derivations and special cases that build on this general theoretical framework and that are now also partly contained in advanced gradient texts on microeconomics. For the analysis of non-use values in the context of FAW provision, it is possible therefore to proceed directly to a description of the empirical framework that is employed in order to measure the potential effect of the two different types of non-use values: E and R .

Discrete choice experiments related to livestock production

A discrete choice experiment (DCE) was used to investigate farmers' willingness to participate in a FAW program, focusing on influences underlying the required program measures, perceived use values (e.g. perceived effects on productivity or production costs) and non-use values derived from enhanced animal welfare (existence non-use values, E) and empirical approximations to paternalistic-altruistic non-use values R (e.g. peer-group effects). Only a

few DCE studies deal with the valuation of programs or contracts that impose changes on farmers' production practices. For example Roe et al. (2004) investigated pig producers' preferences for risk-shifting marketing contracts varying in pricing, a quality premium, contract length, minimum volume delivery requirements and ledger provisions. Besides other results, they show that contract elements that constrain the producer, e.g. delivery requirements, are less preferred. Norwood et al. (2006) present information on cattle producers' acceptance of voluntary checkoff programs. The term checkoff refers to a producer-funded marketing program including commodity promotion, research, and consumer information (Cattlemen's Beef Board 2015). They designed a beef checkoff assessing a fee for each head of cattle sold that would be refunded upon request, while remaining funds would be spent on advertising, promotion or research. Participation in such checkoff programs depends on the actual refund mechanism in place. Calf producers' acceptance of voluntary traceability systems is strongly influenced by the price premium per head, whether the program is introduced by the government or by private industry, and additional information required, e.g. information about production practices, performance or genetics (Schulz and Tonsor 2010). In a study on milk producers' welfare impacts of removing the use of rbST³ from the set of production technologies, Olynk et al. (2012) find that significant welfare losses occur even for differentiated samples regarding the herd size and in those cases where farmers have used rbST before. They conclude that there has to be adequate compensation for forced disadoption of production technologies in order to avoid farmers giving up milk production altogether.

Participation in programs or production schemes or the producers' willingness to sign a contract are plausibly affected by the amount of additional effort and costs that the implementation will cause, but Key (2005) shows that farmers' preference for autonomy also plays a significant role in decision-making. Retaining autonomy as regards the decision to provide a certain level of FAW could also provide another dimension of existence non-use values. The review of DCE-based results may indicate that this component of farmers' preferences can be identified within the context of DCE in particular and may therefore not have been among the set of existence values described by the qualitative interview approach in Hansson and Lagerkvist (2015), for example.

³ Recombinant bovine somatotropin (rbST) is a hormone applied to dairy cows aiming at increasing milk yields.

A compilation of insights from the theory of social interactions and the review of empirical DCE-based literature of farmers' program adoption decisions led to the following hypotheses:

H1: The higher the mark-up on the milk price paid for compliance with a new FAW program, the higher the likelihood of acceptance.

This hypothesis is plausible because a higher milk output price will *ceteris paribus* lead to higher profits from milk production and thus to potential utility gains for the farm household. However, this higher milk price has to be assessed against the potential cost of adopting the FAW program. In this context, it is important to understand that for farmers the consequences of implementing measures to boost FAW are often not entirely predictable. Economic factors such as milk yield, milk quality and productive life span might be affected. Additionally, such measures might impose costs in terms of increasing production costs and the amount of work (for example if pasturing is required) or the opposite of the intended effect (e.g. reduced costs of veterinary treatments). The farmer decides whether or not to accept the program bearing in mind this trade-off between use values and animal wellbeing.

H2: The easier it is to implement the measures of the FAW program, the more likely it is that the farmer will accept the program.

Farmers' acceptance is governed by the amount of utility they derive from a FAW program. Besides changes in use values, changes in non-use values due to enhanced animal welfare might also affect their adoption behavior.

H3: The higher the perceived use values (UV) of the new FAW program, the higher the likelihood of acceptance.

Concerning the practicability of FAW program requirements (pasture grazing, requirements of space for animals *etc.*) due to differences in farm structure, relative implementation costs may vary and therefore it is hypothesized that:

H4: The higher the farmer values program attributes associated with perceived animal wellbeing (non-use existence values, NUV), the more likely it is that the farmer will accept a production scheme.

Examples of farmers' non-use existence values E related to the wellbeing of dairy cows are described in Hansson and Lagerkvist (2015). Similarly, Austin et al. (2005) developed empirical measures to identify farmers who derive value from the wellbeing of dairy cows. Farmers were asked if they regularly check their animals even when there are no health problems, if

they consider costs before calling the veterinarian to a sick animal and if they place any importance on the cows' ability to perform their natural behavior. These measures are used in order to approximate the otherwise unobservable non-use existence values E .

H5: The more social interaction the farmer has with other peers on FAW issues, the more likely it is that the program will be accepted.

Interaction with other peers is measured in terms of interactions with other farmers about FAW issues, but also in terms of contact with farm advisory services. In this context Gunnesch-Luca et al. (2010) investigated the role of trendsetting for the adoption of agricultural innovations. Trendsetters are those who intensively adapt information on innovations and like to pass on and explain that information to others, therefore positively influencing the diffusion of innovations (Gailhard et al. 2012). Farmers who share information on FAW with their social network and/or peer group and furthermore participate in events related to FAW are assumed to be more likely to accept a FAW program than farmers who do not.

3.3 Empirical implementation

DCE is a common tool to reveal determinants of farmers' adoption behavior and allow the amount of monetary compensation necessary to encourage participation in a scheme to be derived. This study aimed to reveal *ex ante* farmers' willingness to participate in a farm animal welfare (FAW) scheme in dairy farming. The empirical analysis in this study was based on primary data collected at an international trade fair for animal production in Hannover, Germany (EuroTier) in November 2014 using a paper-based questionnaire.

As Europe's most important milk producer, Germany faces challenges due to concentration processes leading to growing herd sizes on a diminishing number of farms (BMELV 2014). Partly due to this rapid structural change, there is much debate within the sector surrounding animal welfare in livestock farming: dairy farms are increasingly perceived as large commercial enterprises, potentially with adverse effects on FAW. For these reasons, Germany is a relevant country for the implementation of DCE addressing FAW programs.

Prior to the actual DCE survey, the questionnaire and the choice experiment in particular were pre-tested using a sample of 15 dairy farmers to ensure the comprehensibility of the questions and the choice task. A total of 126 dairy farmers completed the questionnaire at the fair, but

only 78 farmers⁴ answered all the questions. Participants were first asked whether they were milk producers and then were informed about the motivation and purpose of the study. The questionnaire comprised four sections. The first section addressed general attitudes towards farm animal welfare, including items to measure the relationship with their animals and a profit motivation (explained in detail in 3.2). In the second section, after providing information about the requirements of a hypothetical FAW scheme, four choice sets were presented and farmers were asked to indicate which scheme they would implement on their own farm.

To obtain a better understanding of the farmers' views on animal welfare in dairy cattle management, semi-structured interviews with four dairy farmers were undertaken prior to data collection. An analysis of transcripts revealed that farmers strongly associated animal welfare with the health status of their livestock and that a good health status depended mainly on the housing conditions and space available. A cubicle barn with freedom to move was stated as a suitable housing system for sustaining the animals' wellbeing. Interestingly, all the farmers interviewed said that they attached great importance to their animals' wellbeing for reasons other than higher productivity. Although the interviewees could not specify these reasons, they described them as: "getting a good feeling from treating them (the animals) well", "if your animals are sick, you can't be happy", "seeing cows in a poor condition has a negative effect on enjoyment at work". These statements appear similar to those in Hansson and Lagerkvist (2015) and indicate the potential importance of dairy farmers' non-use values in relation to FAW.

⁴ Garrod and Willis (1998) analyzed choice data obtained from a survey of 73 local respondents about their willingness to pay for a reduced impact from landfill waste.

The choice experiment

Based on insights obtained from the interviews, cubicle barns of varying sizes (ranging from 4.5 m² to 5.5 m² with an animal-feeding place ratio of 1:1.2) were selected as an attribute for the FAW. Since access to pasture is socially desirable and some consumer groups show a positive willingness to pay (Olynk et al. 2010; Weinrich et al. 2014), some European dairy companies (for example Arla Foods and Friesland Campina) are responding to this demand with pasture-based programs. In accordance with information obtained from the marketing manager of a German dairy company, access to pasture was chosen as a relevant attribute for a FAW program. Additionally, somatic cell count limits of 125,000 cells 10³ per mg and 150,000 cells 10³ per mg and a required veterinary check once or twice a year were included as measures. Since the FAW scheme in this hypothetical setting was being introduced by a dairy company, a price premium was added on the standard milk price (between 1.0 and 2.0 euro cents per kg milk) as an incentive to encourage farmers' acceptance.

After selecting attributes and corresponding levels, an orthogonal fractional design was generated by means of SPSS comprising 24 choice sets out of all the possible combinations of attributes and corresponding levels. The D-efficiency value was 99.29 – sufficiently close to the maximum value of 100 for a perfectly orthogonal and balanced design (Kuhfeld et al. 1994). In order to make the number of choice tasks manageable for farmers, the sets were blocked into six versions, with four choice sets in each block. Each choice set encompassed two FAW schemes and an opt-out representing non-participation. Due to the voluntary nature of the scheme, the inclusion of such opt-outs was deemed realistic. Table 3.1 shows a typical choice set presented to the farmers.

Table 3.1 Example of a Choice Set

Attributes	Scheme 1	Scheme 2	Opt-out
Outdoor system	Yard	Access to pasture 120 days per year	No FAW program
Housing system	5.0 square meters per animal	5.5 square meters per animal and animal-feeding place ratio of 1:1.2	
Somatic cell count (10 ³ per milligram)	< 125,000	No requirements	
Veterinary check	Twice a year	Once a year	
Premium on standard milk price (euro cents per kilogram)	2.0	1.5	
I choose:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Further determinants of FAW program acceptance by the farmers were measured as follows:

Business orientation

Productivity and welfare objects can be in conflict with one another and challenge farmers on the one hand to deliver higher FAW to meet societal and governmental expectations and on the other to maintain profitability in order to stay in business. Different strategies to cope with this conflict depend on individual differences in farmers' welfare attitudes.

Based on the approach of Austin et al. (2005), the farmers' business orientation reflecting an attitude that views farm animals mainly as a means for doing business was added. Items 25, 26, 27 and 28 listed in Table 3.3 were used to measure business orientation.

The role of paternalistic-altruistic non-use values

In order to develop empirical measures for variables that relate to social interaction and that may influence the farmers' decision to adopt a hypothetical FAW program, communication behavior was measured in terms of information sharing among peers and participation in FAW-related information events. To reduce the complexity of data and identify a business orientation as well as an indicator of communicative behavior, PCA was employed. With an eigenvalue of 1 as the cut-off criterion, two factors with sufficient values of Cronbach's Alpha (measuring scale reliability) were identified. Table 3.2 reports the results of the PCA including factor loadings and share of variance explained by the factors.

Table 3.2 Results of the PCA

Construct	Factor loading
N = 78	
Business orientation (Cronbach's Alpha=0.64; % of variance explained=24.5)	
High milk yield = AW	0.63
Public opinion	0.53
Productivity	0.82
Profit	0.73
Communication behavior (Cronbach's Alpha= 0.65; % of variance explained = 19.8)	
Information sharing	0.86
Participation in events	0.83

3.4 Data and descriptive results

Table 3.3 Summary statistics of respondents

N = 78					
No.	Variable	Mean (SD)	Min	Max	Explanation
1	Milk yield	8945.5 (145.3)	6000	11500	Average milk yield in kilograms per cow per year
2	Herd size	149 (20)	8	1300	Number of dairy cows
Absolute values					
3	Small herd size	16			Number of farms with a herd size \leq 50 cows
5	Large herd size	45			Number of farms with a herd size \geq 100 cows
6	Region				
	North	36			Farm is located in the northern part of Germany
	East	2			Farm is located in the eastern part of Germany
	South	14			Farm is located in the southern part of Germany
	West	20			Farm is located in the western part of Germany
	Foreign countries	3			Farm is located abroad
	Dummy variables (1=yes)	Proportion of affirmative response (SD)	Min	Max	Explanation
7	Farm manager	61% (5%)			Respondent is a farm manager
8	Cooperative	63% (5%)			Farmer is a member of a cooperative
9	Advice	91% (3%)			Farmer employs an advisory service
10	Successor	52% (6%)			Farm has a successor
11	Quality management	91% (3%)			Participation in quality management system
12	Very low somatic cell count (SSC)	31% (5%)			< 150,000 cells per milligram
13	Low somatic cell count (SSC)	43% (6%)			150-200,000 cells per milligram
14	High share of income from milk production	56% (6%)			Income from milk production is >70 %
15	Low share of income from milk production	8% (3%)			Income from milk production is < 50 %
16	Paddock	16 Mean: 3.6	1	7	Farm has a paddock for cows Item: how easy or hard is it to implement a paddock within the next year? ⁵
17	Pasture	35 Mean: 2.7	1	7	Farm has grassland for pasturing Item: how easy or hard is it to implement pasture grazing within the next year? ⁵
18	Cubicle barn	80 Mean: 5.2	1	7	Farm has a cubicle barn Item: how easy or hard is it to implement a cubicle barn within the next year? ⁵
19	Animal health monitoring	42 Mean: 5.5			Management includes health monitoring Item: how easy or hard is it to implement health monitoring within the next year? ⁵
20	Relative practicability	Mean: 3.8	1	7	Total relative practicability ⁶

⁵ Items are measured using a 7-point Likert scale ranging from very difficult to implement (1) to very easy to implement (7), excluding those who have already implemented the required measure.

⁶ Variable 20 was generated by computing the sum score of variables 16, 17, 18 and 19.

The summary statistics of respondents were similar to the population of German dairy farmers. The sample average milk yield of 8945.5 kilograms of milk per cow per year was compared with the average milk yield of 7400 kilograms per cow in Germany in 2013. The sample average herd size of 149 cows per farm was higher than the average herd size of all German farms (54 cows per farm, BMELV 2014), however this national average also contained a large number of part-time farms or farms that will soon go out of business, such that the sample average herd size can be viewed to represent the modern, professional German dairy farm for which the potential adoption of a voluntary FAW program is most relevant. This indicates a sample that is slightly above the statistical average and probably representative of larger, more commercially-oriented dairy producers in Germany.

Table 3.3 (continued)

No.	Variable	Mean (SD)	Min	Max	Explanation
21	Regular check	6.2 (1.1)	2	7	Item: I check my animal regularly, even when there are no health problems. ⁷
22	Natural behavior	6.1 (1.0)	3	7	Item: It is important for animals to be able to perform their natural behavior. ⁷
23	Sympathy with animal	6.0 (1.0)	4	7	Item: I do not consider costs before calling the vet to a sick animal. ⁷
24	Non-use values ('existence')	18.4 (2.0)			Index of variables 21, 22, 23 (sum score)
25	High milk yield = AW	5.6 (1.4)	2	7	Item: A high milk yield is an indicator of animals' wellbeing. ⁷
26	Public opinion	5.5 (1.8)	1	7	Item: Public opinion should not dictate AW standards. ⁷
27	Productivity	4.9 (1.6)	1	7	Item: Productivity of animals should be a farmer's first priority. ⁷
28	Profit	3.2 (1.5)	1	6	Item: I think of my stock mainly in terms of profit. ⁷
29	Business orientation				Factor loadings of items 25, 26, 27 and 28
30	Information sharing	5.1 (1.4)	2	7	Item: How often do you share information about innovations in the field of AW? ⁸
31	Participation in events	4.7 (1.5)	1	7	Item: How often do you participate in events related to AW? ⁸
32	Number of peers for exchange	7 (6)	1	40	Number of peers (family, other farmers) in a regular exchange on FAW issues
33	Communication behavior				Factor loadings items of 30 and 31
34	Effects on milk yield	3.8 (0.6)	2	5	Effect of all measures on milk yield (1= milk yield decreases; 5= milk yield increases)
35	Effects on milk quality	3.8 (0.6)	2	5	Effect of all measures on milk quality (1= milk quality decreases; 5= milk quality increases)
36	Effects on productive lifespan	4.1 (0.7)	2	5	Effect of all measures on productive lifespan (1= productive lifespan decreases; 5= productive lifespan increases)
37	Effects on amount of work	2.4 (0.9)	1	5	Effect of all measures on amount of work (1= amount of work increases; 5= amount of work decreases)
38	Effects on production costs	2.1 (0.8)	1	4	Effect of all measures on production costs (1= production costs are increasing; 5= production costs are decreasing)
39	Use values from program implementation	16.1 (2.7)			Index of variables 34, 35, 36, 37, 38 (sum score)

⁷ Items are measured using a 7 point Likert scale ranging from 1= *fully disagree* to 7= *fully agree*.

⁸ Items are measured using a 7-point Likert scale ranging from 1= *never* to 7= *very often*.

Estimation procedure

To account for the heterogeneity of FAW preferences among farmers, a random parameter (RPL) logit model was estimated that allowed the parameters to vary between individuals and to capture different tastes for FAW measures that were required by the cattle welfare scheme. In contrast to the standard multinomial logit model, this specification captured heterogeneous preferences for FAW program measures arising from different farm and farmer characteristics.

Based on McFadden's random utility theory (1974), farmer n compares alternatives of FAW schemes ($j = 1, \dots, J$) and chooses in choice situation t the alternative that provides the highest utility j^* . However, utility is a latent, not directly measurable construct; instead, only the required measures of the FAW scheme and the characteristics of the farmer and the farm are observable and enter the model as regressors. The utility expression of the general form is therefore:

$$(3.3) \quad U_{nj^*t} = \alpha_c + \beta_n X_{njt} + \theta_j z_n + \varepsilon_{njt}$$

where θ_j is a vector of non-random fixed coefficients multiplied by a set of choice-invariant, observable farm and farmer characteristics z_n , e.g. milk yield or perceived non-use values. Furthermore, x_{njt} represents a vector of observed choice-varying attributes of the FAW program (such as additional pasture or more frequent veterinary checks) and β_n the corresponding vector of coefficients to be estimated. In a RPL model, these coefficients are assumed to be randomly distributed and varying across farmers following a normal distribution, which is a common assumption in random parameter (RPL) logit models, as Louviere et al. (2000) demonstrate.

A constant (α_c) capturing the average effect of all unobserved factors associated with the FAW program on utility is included in the model specification (Train 2003). Instead of two alternative-specific constants corresponding to the FAW programs (alternative 1 and 2) that a farmer faces in a choice set, only one generic constant was added to the model because the alternatives were exclusively described by their attributes and not by a label. The error term ε_{njt} was assumed to be independent and identically distributed. In contrast to the standard logit model, β was allowed to vary among farmers with density $f(\beta_n|\gamma)$ to capture taste heterogeneity. By estimating the population parameters γ , which describe the distribution of

individual parameters (e.g. mean and covariance of the estimated coefficients), individual preferences can be described (Hensher and Greene 2003).

The probability P that farmer n will select from the available choice sets the utility-maximizing FAW scheme j^* can be written as:

(3.4)

$$P_{nj^*t} = \text{prob}(\alpha_{ASC} + \theta_{j^*}z_n + \beta_n X_{nj^*t} + \varepsilon_{nj^*t} \geq \alpha_{ASC} + \theta_j z_n + \beta_n X_{njt} + \varepsilon_{njt}) \quad \forall j^* \neq j$$

Although individuals were being observed over a sequence of choices, the random parameters were considered to be constant for each farmer. This implied that preferences varied across choices, but that an individual's preferences could not vary across repeated choice situations. Given that the individual β_n was unknown, the unconditional probability had to be calculated as the integral of the conditional probability over all possible values of β_n :

$$(3.5) \quad P_{nj^*t}(\gamma) = \int P_{njt}(\beta_n) f(\beta_n | \gamma) d\beta_n$$

Taking a sequence of choices into account, the probability of farmer n 's observed choice decisions is the product of standard logits from each choice (Revelt and Train 1998).

Farm and farmer characteristics were included in the model as interaction terms with the alternative-specific constant to capture the effect on the likelihood of adoption. From the estimated coefficients, willingness to accept (WTA) values could be derived as the ratio of the marginal effect of a FAW scheme measure and the marginal effect of the corresponding farm gate milk price (p_{jn}). WTA values were computed according to equation 3.6:

$$(3.6) \quad WTA_{nj} \text{ for } x_{nj} = \left(\frac{\sum_{n=1}^N \frac{\Delta \text{prob}_{jn}}{\Delta x_{jn}}}{N} \right) / \left(\frac{\sum_{n=1}^N \frac{\Delta \text{prob}_{jn}}{\Delta p_{jn}}}{N} \right)$$

Results

Results from estimation of the RPL model (equation 3.3) are presented in Table 3.4. Regressors can be distinguished into program attributes X and variables that capture individual characteristics of respondents and their farms Z .

Table 3.4 Factors affecting farmers' acceptance of a dairy cattle welfare scheme

N = 78		Coefficient	WTA	WTA
Variable name and number		(SD of random coefficients)	[€cent/kilogram]	confidence interval ⁹ (2.5%; 97.5%)
Program attributes X	Premium on milk price	1.980*		
	Part-time pasture	-3.114** (22.638**)	1.572	(-0.292; 3.437)
	Full-time pasture	-9.327*** (13.732***)	4.709	0.368; 9.050)
	Housing 5.0	-1.626 (6.056***)	0.821	(-0.367; 2.008)
	Housing 5.5	-3.583** (7.348**)	1.809	(-0.216; 3.833)
	SSC 125,000	-9.463*** (14.707***)	4.778	(0.357; 9.199)
	SSC 150,000	-5.527** (10.302***)	2.791	(0.201; 5.380)
	Veterinary check 1	0.0436 (1.831*)	-0.022	(-0.803; 0.759)
	Veterinary check 2	1.602 (14.271***)	-0.809	(-1.978; 0.360)
Individual characteristics of respondents and their farms Z	1) Milk yield	0.001*	-0.001	(-0.0014; 0.0001)
	2) Herd size	0.002	-0.001	(-0.004; 0.002)
	9) Advised farmer	4.467	-2.255	(-5.243; 0.732)
	10) Farmer has successor	0.957	-0.483	(-1.477; 0.510)
	11) Quality assurance scheme	13.257***	-6.694	(-12.543; -0.844)
	20) Relative practicability of implementation	-0.388	0.1959	(-0.130; 0.522)
	24) Non-use existence values (NUV)	-0.680*	0.343	(-0.053; 0.739)
	29) Business orientation	-4.379**	2.211	(0.196; 4.23)
	32) Number of peers for exchange	0.344**	-0.173	(-0.341; -0.006)
	33) Communication behavior	1.698*	-0.857	(-1.874; 0.159)
39) Use values (UV) from program	1.692***	-0.854	(-1.616; -0.092)	
Constant		-41.207**	20.806	(2.916; 38.695)
Simulated Log-Likelihood		-266.43		
AIC¹⁰		590.85		

Levels of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

⁹ Following Hole (2007) the delta method is used to compute accurate confidence intervals.

¹⁰ The AIC for a CL model was 666.38, indicating a better fit of the RPL specification.

Table 3.4 presents estimated regression coefficients with standard deviation for random effects parameters in parentheses and estimated willingness to accept (WTA). Statistical levels of significance are indicated by different “*” (see legend at the bottom of Table 3.4).

Estimated coefficients on program attributes were plausible overall and reflected the rising cost of adopting the various components of the program. The statistically significant standard deviation parameters indicated the existence of heterogeneous preferences among farmers. This, in turn, gave rise to consideration of the RPL specification as appropriate. As was to be expected, a milk price premium for program participation in general also significantly increased the probability of the program being accepted, which implied that there was a failure to reject hypothesis H1. A similar effect was indicated by the negative and significant constant that was estimated. This constant had to be interpreted as the average level of rejection of any FAW program relative to not subjecting their farm to such a program.

Furthermore, program components that could be thought of as being more difficult to implement than others exhibited increasingly negative coefficients and required a higher WTA in euro cent additional price per output price of milk. For instance, relative to the *status quo* of no pasture, part-time pasture reduced the probability of accepting the program, and was accepted if an average price premium of 1.57 euro cents/kg milk output was paid, while full-time pasture exhibited an even more negative coefficient. Similar findings were obtained for increasing levels of space and increasing restrictions on the maximum number of somatic cells that could be contained in delivered milk (note that SSC 125,000 is a more restrictive measure than SSC 150,000 in this respect, and consequently this was reflected by the estimated coefficients). Based on these findings, there is a failure to reject hypothesis H2.

Interestingly, more frequent veterinary check-ups as mandatory elements of a farm animal welfare program were associated with increasing willingness to accept the program. In this context, the econometric model also controlled for perceived relative compatibility of the program attributes, which tested hypothesis H2. Various control questions (variables 16, 17, 18 and 19 in Table 3.3) were combined into a sum score index (variable 20) that was high if respondents perceived the program attributes to be relatively easy to implement on their farms. Interestingly, the corresponding coefficient on this variable was insignificant, which indicated that the random parameter specification of program attributes was apparently better suited to capturing the heterogeneity of the perceived relative compatibility of program measures than this variable, which captures practicability at farm level.

However, the estimated coefficient on the index of use values was positive and significant. This meant that respondents on average perceived some or all program attributes as contributing to their eco-productivity in a positive way. Consequently, the probability of adopting a FAW program increased with the perceived productivity benefits (use values) that respondents attributed to the program. Consequently, there was a failure to reject hypothesis H3. Perceived productivity benefits were closely linked to the farmer's individual characteristics. The variables that captured the individual characteristics of respondents and their farm provided a more nuanced and slightly less obvious picture that required further interpretation.

Apparently, typical socio-economic variables that describe dairy herd size, whether the farmer has a successor and whether the farmer uses advisory services or not, proved to be insignificant. This suggested that according to these criteria no typical group of farms could be identified that would be more likely to adopt a FAW program than other farms. However, farmers who had a relatively high average milk yield per cow appeared more likely to adopt a FAW program. High milk yield may be interpreted as a signal of high input intensity, *e.g.* as a result of high quality forage, successful breeding, a high level of fertility and low rates of mastitis. It is likely that all these factors that are known to be important determinants of milk yield can also be interpreted as signals of farmers' individual levels of knowledge, attention and care when handling their dairy cattle.

In other words, successful, ambitious and caring dairy herdsman can be found on farms of any size, according to the results in Table 3.4. This was also supported by the significant positive coefficient estimated for the farm's participation in a quality assurance scheme. This quality assurance scheme is a voluntary program introduced by the German dairy industry and is widespread across the country. The program defines minimum standards of process quality and documentation on milk production on farms, but does not contain any FAW requirements that would go beyond the public legal minimum. Thus, the significant positive coefficient from this regressor must be interpreted as the effect of farmers already being accustomed to working in accordance with a voluntary standard and being used to documenting routines and processes. Given that the WTA for the program is reduced by 6.7 euro cents/kg milk output among those farmers who already participate in the QM scheme, this may also indicate that adoption of a program itself is, from the farmers' perspective, associated with high transaction costs. Once a program has already been adopted, these transaction costs are lowered, such that subsequent programs tend to be adopted more flexibly.

Furthermore, communication behavior (variable 33 in Table 3.3) and the number of peers for exchange (variable 32 in Table 3.3) revealed positive and significant coefficients. This finding showed that adoption of a FAW program among dairy farmers seemed to follow similar patterns to the adoption and diffusion of other farm technologies. However, it was also an indication of the fact that social context had an influence on farmers' decision-making when it came to FAW. Therefore there was a failure to reject hypothesis H5.

Turning now to the estimated effect of the respondents' set of personal values and attitudes about the wellbeing of their dairy cows (hypothesis H4), the following picture was revealed. The indicator for individual business orientation when dealing with animals showed that individuals who viewed their cows mainly as a means of doing business were less likely to adopt a FAW program than respondents who scored relatively low on this index of business orientation within the human-animal relationship. In turn, this implied that respondents who did not view the relationship with their dairy cows primarily under the aspect of profit maximization were more likely, all other things being equal, to adopt a FAW program.

The estimated effect on the role of non-use existence values on the probability of adopting a FAW program was harder to interpret: respondents who scored relatively high on survey questions that intended to approximate the level of individual non-use values were significantly less likely to adopt the program. At first glance, this did not appear plausible because it could be expected that individual benefits derived from adopting the program would be even greater if the personal level of perceived non-use existence values were high. This would mean that for two farmers with otherwise identical farms and levels of business orientation and use values, the farmer with a higher index of non-use values would derive additional utility gains from adopting the program compared to his or her counterpart with a lower index of this type of non-use values.

However, the estimated negative coefficient could be explained by dividing respondents into the three subgroups of program adoption: out of N= 78 respondents, 12 farmers had never accepted a scheme ("never adopter"), 28 farmers had always accepted a scheme ("always adopter") and 38 farmers had decided selectively ("selective deciders").

Table 3.5 Correlation coefficients for selected variables according to program acceptance decision¹¹

		NUV	UV	Herd size	Milk yield	Business orientation	QM
Entire sample N=78	NUV	-	0.1472	0.0005	-0.0534	0.1231	0.0733*
	UV		-	-0.0164	0.1768	0.0545	-0.0129
	Herd size			-	0.1923*	0.2976**	0.0351
	Milk yield				-	0.2773**	0.0321
	Business orientation					-	0.0925**
	QM						-
Never choose program	NUV	-	-0.3217	-0.0504	0.1961	-0.0513	0.1077
	UV		-	0.0448	0.2796	0.4234	0.1403
	Herd size			-	0.2975	0.5858**	0.1231
	Milk yield				-	0.6412**	0.1864
	Business orientation					-	0.1864
	QM						-
Sometimes pro- gram	NUV	-	0.2991*	0.0693	-0.0670	0.0504	0.0718
	UV		-	-0.1150	0.2248	-0.0787	0.0149
	Herd size			-	0.2740*	0.1542	-0.0029
	Milk yield				-	0.1617	0.0073
	Business orientation					-	0.0090
	QM						-
Always choose program	NUV	-	0.0658	-0.0191	-0.0591	0.1886	0.1254
	UV		-	0.1700	0.0714	0.0576	-0.1006
	Herd size			-	0.0489	0.4057**	0.0508
	Milk yield				-	0.3664**	0.0643
	Business orientation					-	0.1647*
	QM						-
Type of correla- tion test	NUV	-	Spear	Spear	Spear	Spear	Rank
	UV		-	Spear	Spear	Spear	Rank
	Herd size			-	Pearson	Spear	Rank
	Milk yield				-	Spear	Rank
	Business orientation					-	Rank
	QM						-

Levels of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3.5 demonstrates that perceived program use values and non-use existence values did not correlate in a statistically significant way for the overall sample. This was not the case either for the two groups of “never adopters” and “always adopters”. However, use values and non-use existence values showed a correlation in the group of those respondents who decided about their choice with regard to the new program according to the benefit of the specific choice situation.

¹¹ For numerical variables, Pearson's R (Pearson's product moment correlation coefficient) is a measure of linear correlation. Spearman's rho (rs) computes the correlation between two ordinal, or ranked, variables. Point biserial is used when one variable is interval/ratio and the second is dichotomous. Rank biserial (Somers D) is used when one variable is ordinal and the second is dichotomous. Significance levels refer to a test against the null hypothesis of insignificant correlation

The group of “never adopters” in particular scored surprisingly high on the index of non-use values, as shown in Figure 3.1. Apparently, there is a group of farmers who derive a relatively high level of utility from their animals due to factors that are unrelated to use values, and at the same time this group of farmers seems to derive disutility from a FAW program scheme, regardless of its attributes. Interestingly, both “never adopters” and “always adopters” showed a significant positive correlation between their business orientation and herd size and milk yield. This implied that within these two groups the more productive and larger dairy farms also tended to have a higher business orientation, and for the group of “always adopters” business orientation was also positively related to the probability that the farm was participating in the voluntary quality assurance scheme (QM).

Focusing further on the distribution of stated non-use existence values according to these three groups is facilitated by Figure 3.1. This figure shows that in the group of “never adopters” no observations occurred in the lower range of the non-use existence value index. In turn, the lowest values of this index were observed in the group of “always adopters”. Of course, both groups also revealed relatively as high values as those given by the group of “selective deciders”. Furthermore, in all three groups there was a tendency for stated non-use existence values to be higher as the size of the dairy herd increases.

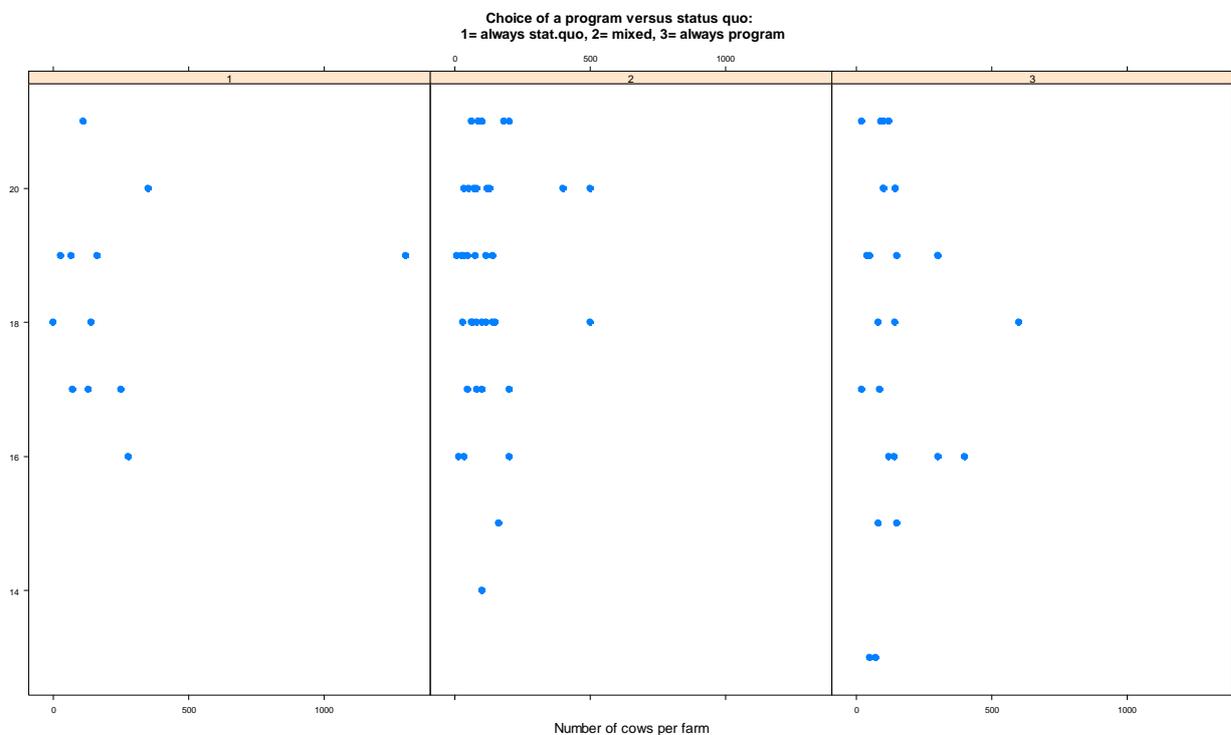


Figure 3.1 Stated NUV in relation to size of dairy herd, according to the groups of respondents.

Figure 3.1 makes it clear that the number of observations in this context was too small to draw general conclusions. However, this figure may help to interpret the finding of the negative estimated coefficient on non-use existence values in the random parameter logit (RPL) model in Table 3.4: the group of “never adopters” had relatively high non-use existence values and at the same time perceived an additional transaction cost when adopting the program. Thus, adoption of the program did not seem to be complementary to personal non-use values. This could be because this group of farmers were very well aware of their own high standards of animal treatment and therefore would perhaps prefer to have the public trust them without the need for a program. In other words, for this group the program could constitute an unnecessary administrative burden that addresses nothing more than these farmers feel is currently being addressed anyway.

In contrast, the group of “always adopters” seemed to perceive an additional benefit from adopting the program, and this benefit was not captured by the explanatory variables in the RPL model in Table 3.4. Such a benefit could be identified based on the conceptual framework of the theory of social interactions: adopting a program beyond perceived use values and stated relative practicability means an additional burden or forgone income from animal production. Given that non-use existence values were rather low in that group, they failed to provide an explanation for it. However, the burden of program adoption paid off for the farmers in this group due to the additional utility gains they derived from enhancing their reputation among other members of the society. These paternalistic-altruistic non-use values were in line with the theory of social interactions and may refer to an increase in prestige or image among other farmers or among consumers and policymakers.

3.5 Discussion and conclusions

Based on a randomly selected sample of 78 German dairy farmers, several hypotheses were tested about the relationship between acceptance of a FAW program on the one hand and socio-economic characteristics, approximation indices to individual levels of use values, non-use values and business orientation on the other. Empirical results from a random parameter logit (RPL) model failed to reject all the hypotheses initially formulated, except for one: farmers with relatively high levels of individual non-use existence values regarding the well-being of their animals turned out to be correlated with a group of farmers who never accepted any variant of the hypothetical FAW program, as presented to them in the corresponding DCE. This skepticism was not explained by program design or by possible difficulties in im-

plementing the program on a specific farm. Furthermore, the subgroup of “never adopters” of the program did not reveal any significantly different socio-economic characteristics than the overall sample of respondents on average.

These findings were therefore interpreted as evidence of a significant level of disutility that some farmers derived from a FAW program itself. Potential sources of this disutility could be the perceived loss of autonomy when handling their own dairy cows in accordance with a program or a lack of familiarity with voluntary quality programs *per se*. However, as one of the main findings, it was concluded that these results did not allow the rejection of a FAW program by individual farmers to be viewed as potential evidence of claims that these individuals do not value a FAW program.

In turn, these findings on the estimated effects of use values showed that farmers who believe that FAW program attributes would increase the productivity and profitability of their dairy herd acted rationally when deciding to adopt a program.

The theory of social interactions was used in order to motivate the farmers' decision to adopt a new FAW program based on such use values that were explained by the incentive to maximize profits, but this concept was also used to argue that non-use values may affect the decision beyond plain profit maximization goals. Instead, these results showed that the decision to adopt a new FAW program was the result of a complex interaction of considerations that ultimately led to utility maximization of the farm household. Consequently, the commonly held belief that farmers provide FAW only insofar as it is profit maximizing is potentially too narrow and should, at least in the case of dairy farmers, be extended to farm household utility maximization.

These results suggest in this context that further research is required in order to confirm the potential role of non-use existence values on the one hand, which may describe farmers' intrinsic attitudes towards animals, and non-use values of paternalistic altruism, which in line with the theory of social interactions may describe farmers' extrinsic attitudes towards their image or prestige among relevant peer groups (e.g. other farmers or consumers).

Regarding private and public sector policies, these results suggest that farmers' individual perception of FAW values may in the past have been too narrowly reduced to presumed economic drivers. Instead the results of this study suggest that some farmers also reveal a substantial non-use valuation of FAW, either from an extrinsic or intrinsic motivation. These farmers may substantially contribute to the provision of certain public goods in relation to the

wellbeing of farm animals. However, some of these farmers seem at the same time to have a strong aversion to FAW programs in themselves.

Future research should therefore determine whether this general program rejection is related more to a perceived loss of autonomy when handling their farm animals or is an expression of perceived high transaction costs when adopting a program in general.

Future design and related extension work that seeks to increase the adoption of FAW programs could then potentially address these factors proactively, which may ultimately lead to higher adoption rates of FAW programs among dairy farmers.

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Chapter 4

Predicting supply and demand for high-welfare meat with Discrete Choice Experiments: an application to the German pork market

Author

Julia Anette Schreiner

Abstract

This study relates pig farmers' willingness to provide higher levels of farm animal welfare (FAW) with consumers' willingness to pay for pork cutlets produced in compliance with higher standards. Discrete choice experiments (DCE) were employed using choice sets that only differ in the price variable for both, farmers and consumers. Based on preference estimates from a random parameter logit (RPL) model, supply and demand curves were derived and market equilibria for varying levels of animal welfare pork in Germany were estimated. Data was collected from 140 pig farmers and 626 pork consumers in Germany using online questionnaires and personal interviews. The RPL model revealed that farmers who state a long-term planning horizon and who are selling pork directly to consumers are more likely to accept a FAW program. Furthermore, the analysis of consumers' preferences for animal welfare when buying pork cutlets showed that an increase in product price and increasing duration of transportation to abattoirs negatively affected the probability of purchase. Consumers who frequently purchase pork over the self-service counter, attach more importance to price than to brand, origin or taste of pork, are less likely to buy high-welfare pork. Moreover, individuals who prefer conventional to organic pork are less likely to buy high-welfare pork cutlets. Market simulations for high-welfare pork indicate increasing divergence in supply and demand with higher FAW standards. For a FAW program with standards only slightly above the legal minimum standard, a market share of 38% was predicted, whereas for a program with considerable higher requirements, market balance has not been achieved at all.

Keywords farm animal welfare, discrete choice experiment, random parameter logit, market simulation

4.1 Introduction

The ongoing debate on farm animal welfare (FAW) at both the national and international level led to numerous initiatives aiming at enhancing animals' wellbeing. Well known examples are the *Welfare Quality*[®] standard in Europe, the chain-wide Quality and Safety (QS) certification system in Germany, and a catalogue of above-minimum criteria developed by the German Farmers Union (DBV 2015). Although high-welfare meat is available on the German market, and some consumer groups are willing to pay a price premium (Meuwissen et al. 2007; Schulze et al. 2008; Lagerkvist and Hess 2011), the consumption accounts for only two percent, including meat produced under organic schemes (Spiller et al. 2010). In contrast to

the reluctant demand for high-welfare meat, around 90% of the German population states to be concerned about the treatment of farm animals in livestock production (TNS Deutschland GmbH 2012). This discrepancy reflects the widespread opinion that attitudes expressed by consumers may not be related to their purchase behavior (Grunert 2006; Te Velde et al. 2002). In the literature on consumer behavior this phenomenon is often described as “citizen consumer gap” or “attitude behavior gap” (Vermeir and Verbeke 2006; de Bakker and Dagevos 2012; Harvey and Hubbard 2013). A citizen’s positive attitude towards animal welfare may not affect actual purchase behavior, but may provide some potential that can be tapped through marketing and communication activities (Verbeke 2009). To enable consumers to consciously purchase high-welfare meat, the Federal Government of Germany considers launching an animal welfare label. Animal welfare labelling can be used to indicate a desired quality to consumers. Moreover it can be used by producers as an instrument for product differentiation. Franz et al. (2010) argue that the product differentiation has to start initially at the farm level. Thus, producers’ participation in such initiatives is a prerequisite for its success. However, the implementation of stricter animal welfare requirements is a problematic issue as higher animal welfare standards likely imply additional costs for pig farmers (Liljenstolpe 2008) and a potential loss in productivity due to the constraints imposed on livestock husbandry. Thus, deciding the economically viable amount of FAW requires a trade-off between better animal wellbeing and productivity. The present study aims to ascertain the determinants of pig farmers’ participation in FAW programs as well as factors influencing consumers’ purchasing behavior towards high-welfare pork¹². The analysis is based on data obtained from discrete choice experiments (DCE).

Previous studies on preferences for FAW have only considered one side of the coin—either producers’ willingness to provide higher levels of animal welfare or consumers’ willingness to pay for food produced under animal-friendly conditions. The present study adds to the literature by assessing both consumer and producer preferences using a common elicitation format. This allows us to simulate the market for pork produced under different FAW programs. In the next Section (4.2), hypotheses are formulated reviewing the relevant literature on consumers’ preferences for high-welfare pork as well as farmers’ acceptance of FAW programs. Section 4.3 describes the experimental setup. Section 4.4 sets out the econometric model and the survey design. Section 4.5 presents the results of the random parameter logit

¹² The term high welfare pork (or meat) refers to production conditions above the legal minimum standard.

(RPL) model, estimated willingness to accept (WTA) and willingness to pay (WTP) values as well as the market simulation for high-welfare pork in Germany. Results from the estimated models and the market simulations are discussed in Section 4.6 followed by some concluding remarks.

4.2 Literature review and hypotheses

Previous consumer studies confirm that some groups are willing to pay for enhanced FAW in meat production. A comprehensive review on that issue is provided by Lagerkvist and Hess (2011), who emphasize that information on how farm animals are kept can alter purchase behavior. Meuwissen and van der Lans (2004) conducted a conjoint analysis (CA) among Dutch pork consumers and found that respondents were willing to pay a price mark-up for animal welfare attributes, although they are less important than price and taste. Lagerkvist et al. (2006) compared Swedish consumers' preferences for immuno-castration of pigs, surgical castration and no castration. Their results suggest that consumers attach greater value to pork from immuno-castrated pigs than from those who are surgically castrated. In contrast, pork from intact boars was negatively valued because of the potential risk of boar taint. The authors conclude that immuno-castration is a socially accepted alternative to surgical castration providing several potential advantages for the public and agribusiness, including animal welfare improvements, potential cost savings in procedures and gains from higher growth rates for pigs. Similar results were obtained by Liljenstolpe (2008) who suggested that "no castration" should be considered as a food-safety oriented attribute due to the risk of boar taint. Furthermore, it was found that Swedish consumers are willing to pay a supplement for mobile slaughtering to obviate transportation. In a study about product quality attributes from different animal species, Carlsson et al. (2005) reported that consumers ranked allowing fattening pigs to be outdoors as the most important value and they oppose the fixation of sows. These studies demonstrate that nearly all of the investigated measures that are intended to provide higher levels of animal welfare are positively valued by consumers. Therefore, it is hypothesized that:

HCI: The requirements of a FAW program that are meant to provide higher levels of animal welfare have a positive impact on the likelihood of purchasing high-welfare pork cutlet.

Meuwissen and van der Lans (2005) approached the investigation of consumers' trade-offs between different pork by means of a conjoint analysis (CA). Although they could identify consumer segments that are more concerned about food safety and animal welfare, taste and

price were, on average, perceived as the most important characteristics. Also other studies support the assumption that the price weighs heavily on the purchase decision (Grunert 2006; Jonge and van Trijp 2013). This leads to the hypothesis that:

HC2: An increasing price of high-welfare-pork cutlets reduces the likelihood of purchase.

It is well known that socio-economic characteristics and attitudes, values and beliefs influence the purchase behavior. Specific characteristics that are associated with consumers of high-welfare meat are assumed to affect the probability of purchase. For example, Enneking (2004) assumes that respondents who pay attention to animal-friendly production methods also prefer premium brands or organic products to cheap private labels and less known brands. Organic buyers are more likely to be concerned about food-related ethical issues like animal welfare and are thus motivated to buy high-welfare pork.

HC3: People who buy organic products are also more likely to buy high-welfare meat

Taking into account that in Germany the importance of supermarkets for meat sales is increasing steadily up to a current share of 80%, Weinrich et al. (2015) investigated the attractiveness of alternative points of purchase. They revealed that high-welfare meat is not successfully sold over the self-service counter and they recommend placing it at the service counter to address potential target groups.

HC4: People who prefer to buy meat from the service counter are more likely to buy high-welfare pork.

According to Spiller and Schulze (2008), 70% of all grocery shopping is done by women, thus they are assumed to have more knowledge regarding food products and are generally more price sensitive than men. Therefore, it is assumed that the respondents' gender, their expenditure on food and the frequency of consumption will affect the purchase of high-welfare pork. Consumers living in urban regions often feel alienated from the way their food is produced and are increasingly critical of modern agriculture (Duffy et al. 2005). Products claiming better animal welfare conditions might be more likely purchased by people who live in urban regions, distant from animal production.

Farmers' preferences for FAW programs in pork production have rarely been investigated. Although an increasing number of studies deals with farmers' general attitudes towards animal welfare (Austin et al. 2005; Bock and van Huik 2007; Lagerkvist et al. 2011; Franz et al. 2012), little is known about farmers' willingness to participate in FAW programs. Franz et al.

(2012) identified among 160 conventional German pig farmers three different groups who generally all showed a broad acceptance of the basic principles of the European initiative *Welfare Quality*®. Differences between these groups were found in farmers' understanding of FAW. While all farmers accepted the principles of good housing, good feeding and good health, the appropriate animal behavior is only important for a small group of pig farmers¹³. The authors argue that these varying attitudes might lead to different animal welfare levels farmers are willing to provide. To address these different preferences, they recommend establishing a graduated label starting from a lower quality level leading to higher levels with stricter requirements but also higher rewards. Also Vanhonacker et al. (2008) found a heterogeneous set of farmer's interests influencing their perceptions of FAW: while some were more economically driven, other farmers were also interested to supply high-quality products, have a satisfying job and establish a more positive image of their profession among the public. In comparison to citizen perception, the highest discordance was found for aspects related to animal behavior

Discrete choice studies on animal welfare have mainly been carried out with consumers in order to elicit their willingness to pay. In contrast, only few studies apply this technique to elicit livestock farmers' preferences for quality system requirements. For example, Norwood et al. (2006) revealed information on cattle producers' acceptance of voluntary checkoff programs both in Oklahoma and nationwide. Beef checkoffs were introduced to the U.S. in 1986 to improve beef demand through research, advertising and promotion, consumer information, industry information foreign marketing and producer communication. The main objective of the study was to reveal the amount of fees producers are willing to pay. Furthermore, Norwood et al. (2006) investigated producers' preferences for different refund mechanism. The refunding could be either done by spending the fees on different business activities (advertising, promotion or research) or farmers could request the total amount of money back. Moreover, the authors addressed the problem of free-riding by including a provision point mechanism: a minimum percentage is specified of producers, who do not request a refund. Results showed that cattle producers rated the option to spend funds on advertisement as the most attractive way to donate. If fees are spent on research, only 10% of farmers are willing to participate in the checkoff. While producers responded to the provision point mechanism by in-

¹³ The Welfare Quality project developed a comprehensive approach for the assessment of FAW, which includes four dimensions: good housing, good feeding, good health and appropriate (species-specific) behavior (Keeling and Kjærnes 2009)

creasing their propensity to donate, the response was still too small to tackle the free-riding problem. Another study conducted by Schulz and Tonsor (2010) investigated US cow-calf producers preferences for voluntary tractability systems, managed either by the private sector or the government and varying in the level of information required. Simulated welfare effects showed significant losses when traceability options are removed, in particular for those producers with strong preferences to avoid to collaborate with governmental entities or provision of additional information about their operations. In both studies, a premium paid to encourage farmers' participation was highly valued. Therefore, it is expected that:

HP1: The higher the price mark-up for enhanced animal welfare, the higher the likelihood of acceptance of a FAW program.

The practicability of animal welfare enhancing measures depends on current farm structures such as space available per pig or access to daylight. Considering that the ease of implementation varies across farms, it is hypothesized that:

HP2: The higher the effort necessary to comply with the FAW program, the less likely farmers will accept it.

HP3: The more restrictive the requirements of the FAW program (barn space and duration of transport allowed), the less likely the farmer accept a program.

Farmers use different marketing channels to sell their products. More traditional ways like direct marketing provide a possibility to communicate images of desirable animal welfare status directly to consumers.

HP4: The marketing channel the farmer uses to sell his products affects the likelihood of accepting a FAW program.

Considering a FAW program as a kind of innovation, it can also be assumed that less educated and older farmers are more reluctant accept such a program (Venkatesh 2003).

4.3 Empirical implementation

Table 4.1 gives an overview of the welfare attributes included in the choice sets. Program attributes in terms of requirements farmers have to implement were selected based on existing FAW initiatives in Germany¹⁴ and comprise the barn area available per pig, supply of bedding

¹⁴ The initiatives „Initiative Tierwohl“, Tierschutzlabel für mehr Tierschutz“ and „Aktion Tierwohl“ comprise different requirements for the keeping of pigs, the surgery and transportation to abattoirs.

straw, access to manipulable and rooting material, tail docking and castration (either avoiding castration or tail docking or using anesthesia) and the permitted for transporting pigs to the abattoir. The minimum level was defined by the actual legal requirements and the German quality and safety (QS) standard. The increment on the reference price (1.70€/kg) paid to farmers for participation was calculated applying a cost-engineering approach on the basis of actual costs arising from implementation of FAW requirements. For the consumer choice sets, a reference price of seven Euros per kilogram pork cutlet was assumed. The upper level for the consumer price was set twice as high as for conventional cutlets (14€/kg) which is similar to the price for organic pork. Table 4.2 shows an example of a choice set for pig producers. The choice set for consumers was identical in all aspects, safe for the price variable which was scaled in Euro per kilogram pork cutlet.

Table 4.1 FAW attributes and levels used in the DCE

Attribute	Level
Barn area per animal (m ² per animal)	1) 1.00*; 2) 1.33; 3) 1.66; 4) 2.00
Characteristics of piggery floor	1) Solid floor without bedding*; 2) Bedding straw in part of barn area; 3) Bedding straw in full barn area
Manipulable materials	1) One piece of manipulable material* 2) Three pieces of manipulable material 3) One piece of manipulable material and material for rooting
Surgery	1) Tail docking and castration without anesthesia* 2) Tail docking and castration with anesthesia 3) No surgery
Duration of transportation to abattoir	1) 8 hrs.* 2) 6 hrs. 3) 4 hrs.
Consumer price for pork cutlet in €/kg	1) 7.00* 2) 8.40 3) 9.80 4) 11.20 5) 12.60 6) 14.00
Producer price increment in €/kg carcass weight	1) 0.00* 2) 0.08 3) 0.16 4) 0.24 5) 0.32 6) 0.40

*marks the minimum level (status quo)

The *orthoplan* procedure of SPSS was used to generate an orthogonal design minimizing correlation between attribute levels. The final choice design with a D-efficiency value of 97.1 contained 81 choice sets, from which eight were randomly chosen and presented to 626 con-

sumers and 140 pig farmers. In a choice set respondents were asked to choose between two hypothetical FAW programs and a status quo representing the actual minimum standard (see Table 4.2). Moreover, consumers were asked to provide information on their consumption behavior, their attitude towards FAW and their socio-economic characteristics (e.g. household size, income, age). Pig farmers were asked to provide information about their farming structure, socio-economic factors, their general attitude towards animal welfare labels and if they are generally willing to participate in such a program.

Table 4.2 Choice Set including two alternatives and the status quo

FAW requirements	QS standard (Status Quo)	Label 1	Label 2
Producer surplus €/kg carcass weight // Consumer price for pork cutlet in €/kg	0.00 €/kg // 7.00€/kg	0.18 €/kg // 11.20€/kg	0.24 €/kg // 12.00€/kg
Barn area per animal (m ² per animal)	1.00 m ²	1.00 m ²	1.66 m ²
Characteristics of barn floor	Solid floor without bedding	Straw bedding (full barn area)	Straw bedding (full barn area)
Manipulable materials	One piece	One piece	Three pieces
Surgery	Yes, without anesthesia	Yes, without anesthesia	Yes, with anesthesia
Duration of transportation to abattoir	8 hrs.	6 hrs.	8 hrs.
I would choose:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4.4 The Choice Model

Based on McFadden's (1974) Random Utility Theory, an individual n 's utility U obtained from a most preferred alternative j^* consists of a deterministic observable part V_{nj} and a stochastic part ε_{nj} accounting for factors that are unobservable to the analyst.

$$(4.1) \quad U_{nj} = V_{nj} + \varepsilon_{nj}$$

Assuming that respondents are utility-maximizers alternative j^* will be chosen from a set of alternatives J with a certain probability which can be simulated by means of Maximum Likelihood technique:

$$(4.2) \quad P_{nj^*} = \text{prob}(V_{nj^*} + \varepsilon_{nj^*} > V_{nj} + \varepsilon_{nj}) \quad \forall j = J; j^* \neq j$$

The deterministic part V_{nj} can be described as an additive function of FAW requirements x_{nj} providing different levels of utility. Additionally, it is assumed that the decision makers' per-

sonality (socio-economics characteristics or attitudes) and the farming system or the household structure z_n affect the likelihood of choosing an alternative.

$$(4.3) \quad V_{nj} = \alpha_c + \sum_{i=1}^I \alpha_i x_{nji} + \sum_{m=1}^M \beta_{jm} z_{nm}$$

The constant α_c captures the average effect on utility of all unobserved factors associated with the FAW program. Instead of creating a constant for each alternative, only one generic constant was added because the alternatives were exclusively described by their attributes and not by an alternative-specific label. Estimated parameters α and β (summarized under the designation γ_n) provide information about the influence of alternative attributes and individuals characteristic on the choice probability. To account for heterogeneity within the population (farmers as well as consumers), a random parameter logit (RPL) model was employed which overcomes the limitations of a standard logit model by allowing for random taste variation, unrestricted substitution patterns and correlation in unobserved factors (Train 2003). The utility parameters γ_n vary across the population with density $f(\gamma|\theta)$ where θ are the true parameters of the distribution describing the mean and the variance of γ 's. The attributes of the FAW program are included as random parameters into the model, and the characteristics of individuals interacting with the constant because they do not vary over alternatives (Hanley et al. 2001). From the estimation results marginal effects can be obtained and in turn WTP or WTP be calculated. The marginal effects can be interpreted as the change of the outcome variable (here the likelihood of choice) due to an infinitesimal change of independent variables. For discrete variables it is not appropriate to calculate the marginal effect in terms of infinitesimal changes. Thus, as a preliminary step, the marginal effects are calculated at the mean of the sample and subsequently a discrete change of the variable of interest is simulated that leads to a change in the corresponding probability. The difference of both probabilities represents the marginal effect of the dummy variable or categorical variable.

WTA or WTP estimates are obtained by setting the marginal effect of an explanatory variable (a program attribute x_j or a socio-economic characteristic z_n) in relation to the marginal effect of the price premium (p_{jn}):

$$(4.4) \quad \text{marginal WTA for } x_j = \frac{\Delta WTA}{\Delta x_j} = \left(\frac{\sum_{n=1}^N \frac{\Delta \text{prob}_{jn}}{\Delta x_j}}{N} \right) / \left(\frac{\sum_{n=1}^N \frac{\partial \text{prob}_{jn}}{\partial p_{jn}}}{N} \right)$$

These marginal effects are calculated at the mean of the sample. Instead, individual WTP and WTA values can be computed applying formula 4.6 at the end of Section 4.4.

4.5 Results

Descriptive statistics

Both surveys, with pork consumers and pig farmers were conducted in the winter 2013/2014 using online questionnaires. Collecting consumer data was partly done by interviewing randomly chosen pedestrians in Schleswig-Holstein. Although 779 respondents had participated in the survey, the data from only 629 consumers was used for analysis because the remainder stated that they usually never consume pork. Prior to the main survey, the questionnaire was pretested with consumers and farmers on an agricultural fair in the same region. The summary statistics for the two survey samples are presented in Tables 4.3 and 4.4.

Table 4.3 Summary statistics of surveyed consumers

N = 629		
Variable	Mean (SD)	Explanation
Age	43 (16.2)	Age of respondent
Gender	50% (50%)	Dummy: 1= respondent is female
HH size	2.5 (1.2)	Number of household members, incl. children
HH children	28% (45%)	Households with children
Rural area	9% (29%)	Dummy: 1= Community with less than 500 people
Country town	19% (30%)	Dummy: 1= Town with 500 to 5000 people
Small town*	20% (40%)	Dummy: 1= Town with 5,000 and 20,000 people
Middle-sized town	22% (41%)	Dummy: 1= Town with 20,000 and 100,000 people
City	30% (46%)	Dummy: 1= City with more than 100,000 people
Secondary school	46% (50%)	Dummy: 1= Respondents who have secondary school leaving certificate
Qualification*	25% (43%)	Dummy: 1= Respondents have an entrance qualification for technical college.
College degree or higher	29% (45%)	Dummy: 1= Respondents have at least degree from technical college.
Consumption-related variables		
2-3 days a month	26% (44%)	
Once a week	38% (48%)	
Several times a week	33% (47%)	
Daily	2% (13%)	
Outlets:		
Discounter	19% (39%)	Dummy: 1= Pork purchase mainly in discounter
Supermarket*	55% (50%)	Dummy: 1= Pork purchase mainly in supermarket
Butcher	24% (43%)	Dummy: 1= Pork purchase mainly at the butcher's
Weekly market	2% (14%)	Dummy: 1= Pork purchase mainly at the weekly market

Note: Dummy variables with * were omitted from estimation as reference category

Table 4.3 continued

Variable	Mean (SD)	Explanation
Respondent purchases meat	56% (50%)	Dummy: 1= Over 50 percent of pork is purchased by the respondent exclusively.
Respondent partly purchases of meat*	30% (46%)	Dummy: 1= Purchasing of pork is equally shared with another household member.
Another household member purchases meat	15% (35%)	Dummy: 1= Another household member purchases over 50% of pork.
Fresh meat	58% (49%)	Dummy: 1= Mainly purchase of fresh pork.
Self-service counter	37% (48%)	Dummy: 1= Mainly purchase of pork over the self - service counter.
Frozen meat*	3% (17%)	
Frequently organic	20% (40%)	Dummy: 1= Respondent often purchases organic pork.
Seldom organic*	53% (50%)	Dummy: 1= Respondent rarely purchases organic pork.
Never organic	28% (45%)	Dummy: 1= Respondent never purchases organic pork.
Priority price	28% (50%)	Dummy: 1= Purchaser considers price as very important.
Priority taste*	38% (49%)	Dummy: 1= Purchaser considers taste as very important.
Priority brand	14% (35%)	Dummy: 1= Purchaser considers brand as very important.
Priority origin	20% (40%)	Dummy: 1= Purchaser considers origin as very important.
FAW-related variables:		
Keeping conditions = novelty	3.1 (1,3)	Item: Are the presented keeping conditions new to you? 1-5; 1= not new at all; 5= completely new
Critical attitude	3.5 (1,1)	Item: I am critical of the conditions the farm animals are kept nowadays. 1-5; 1=strongly disagree; 5= strongly agree
Knowledge about pig farming	3.2 (1,1)	Item: How would you assess your knowledge of pig farming? 1-5, 1= not well informed, 5= well informed
Discussion on animal welfare	2.9 (1,1)	Item: I follow the public debate on animal welfare. 1-5; 1=strongly agree; 5= strongly disagree
Consumption increases	3% (17%)	Dummy: 1= Increased consumption if prices for pork increase due to higher FAW
Amount of consumption remains the same*	53% (50%)	Dummy: 1= No changes in consumption if prices for pork increase due to higher FAW
Consumption decreases	31% (46%)	Dummy: 1= Decreased consumption if prices for pork increase due to higher FAW

Note: Dummy variables with * were omitted from estimation as reference category

The average age of consumers was 43 years and half of them were female. Around 30% of the respondents live in households with children and the average household size was 2.5 persons. The educational variables show that almost half of the consumers finished their secondary education and nearly 30% obtained at least a diploma from a technical college. One third of the sample consumes pork once a week, whereas only a minor part (2%) eats pork every day. Over half of the respondents are in charge of purchasing the meat among household members, and also 50 percent prefer supermarkets to discounters, butchers and weekly markets. The

majority of respondents prefer to buy fresh pork at service counters to self-service counters and 38% of the sample ranked taste higher than price, brand and origin. One third attached the greatest importance to price. A fifth of those interviewed stated that they consume organic food products frequently, while almost 30% never do. Consumers' attitude towards FAW was measured using statements expressing a critical view on keeping conditions or if they follow the public debate on animal welfare. Furthermore, respondents were asked if the FAW measures described in the choice sets are new to them and how they assess their knowledge of pig farming. On average, consumers selected the mid-point of scales, indicating that they are only partly informed about the presented FAW measures and have limited knowledge of animal welfare in general. A notable exception makes their rather critical view on the conditions under which farm animals are kept nowadays. Interestingly, over half of the respondents stated that they would consume the same amount of pork even if prices increased due to higher levels of FAW.

Table 4.4. shows the descriptive statistics of the sample of pig farmers. The average age of farmers is 43 years with nearly 40% having a university degree, and over half of them a degree from a technical college. Although most of the farmers face unclear farm succession, they expect to continue farming on average for the next 20 years. The average land size is 99 hectares, and the fattening capacity is on average 1462 fattening places; relatively high numbers compared to the average German farm¹⁵. A low share (4%) of surveyed farms also keeps dairy cows and suckler cows and 9% also keeps fattening beefs and poultry. A small minority of farmers takes part in agri-tourism and sells their products directly to consumers. A considerable share of farmers is selling their fattened pigs to livestock traders or producers' associations, whereas only a few of them conclude contractual agreements or sell pigs directly to a butcher. On average, farmers are neutral when asked about their plans to expand the pig fattening capacity. In general, the surveyed pig farmers assess the public image of agriculture as negative. This might be a reason for the overall positive attitude towards a high-welfare label and high share of farmers who are willing to participate in a FAW program (65%).

¹⁵ In 2013 only 12% of all pig keeping farms in Germany kept more than 1000 fattening pigs. The average farm size of pig keeping farms in 2013 accounted for 52 hectares per farm (BMELV 2014).

Table 4.4 Summary statistics of surveyed farmers

N = 140

Variable	Mean (SD)	Explanation
Age	43.4 (11.3)	Farmer's age
High education	37% (48%)	Dummy: 1= Farmer holds a university degree or PhD
Further education	56% (49%)	Dummy: 1= Farmer holds a degree from a technical college
Basic education	6% (25%)	Dummy: 1= Farmer has vocational training
Farm acreage	99 (68.2)	Hectares of farm land
Successor	31% (47%)	Dummy: 1= Yes, succession is secured; 0 = No successor
Succession is unclear	54% (50%)	Succession is unclear
Time remaining farm manager	21 (10.9)	Years planned to remain farm manager
Fattening units	1462 (1161)	Number of fattening places on farm
Dairy cows	4% (20%)	Dummy: 1= Dairy cows kept on farm
Keeping suckler cows	4% (19%)	Dummy: 1= Keeping suckler cows
Cattle fattening	9% (28%)	Dummy: 1= Cattle fattening practiced on farm
Piglet breeding	40% (49%)	Dummy: 1= Piglets breeding practiced on farm
Piglet rearing	35% (48%)	Dummy: 1= Piglets rearing practiced on farm
Pig fattening	93% (26%)	Dummy: 1= Pig fattening practiced on farm
Poultry	9% (29%)	Dummy: 1= Poultry kept on farm
Tourism	3% (17%)	Dummy: 1= Farm offers agri-tourism
Marketing of pigs		
Livestock traders	57% (50%)	Dummy: 1= Pigs are sold to livestock traders
Short-term delivery contract	6% (23%)	Dummy: 1= Short-term delivery contract
Long-term delivery contracts	9% (28%)	Dummy: 1= Long-term delivery contracts
Producer organization	36% (48%)	Dummy: 1= Pigs sold through producer organization
Direct marketing	4% (20%)	Dummy: 1= Pork is sold directly to consumer
Butcher	11% (31%)	Dummy: 1= Pigs are sold directly to butcher
Willingness to invest	2.8 (1.1)	Item: Are you planning to invest pig fattening? 1-5; 1= strongly disagree; 5= strongly agree
Image of agriculture	4 (0.8)	Item: How would you assess the public image of agriculture? 1-5; 1= very positive; 5 = very negative
Attitude towards animal welfare label	2.8 (1.3)	Item: What do you think about the introduction of an animal welfare label for pigs? 1-5; 1= strongly like it; 5= strongly dislike it
Willingness to participate	65% (48%)	Dummy: 1= farmer is willing to participate in a FAW program if arising costs are covered.

4.4 Estimation results

This section presents the estimation results from the RPL model for both consumers and farmers. First, the estimation was done with all variables that might have an influence on the likelihood of purchase or, in the case of farmers, on the willingness to adopt a FAW program. Subsequently, a parsimonious model¹⁶ which only includes significant variables was estimated. Secondly, the marginal consumers' willingness to pay (WTP) and the marginal compensation that has to be paid to farmers to achieve program acceptance (WTA) were calculated from the marginal effects (see formula 4.4)¹⁷. A total of 5032 choice sets were included in the estimation of the consumer model. In 63% of choices, respondents preferred a higher welfare pork cutlet to the one produced in accordance with minimum standards. In total 339 (54%) consumers always chose a pork cutlet produced under enhanced animal welfare conditions, whereas 57 (9%) of them never chose such a product. The remaining 233 (37%) individuals chose a high-welfare cutlet only in some situations. Table 4.5 shows the regression results from the consumer model, with the upper section presenting the coefficients of the FAW program measures and the lower section the behavioral variables as well as socio-economic characteristics. As expected, a high price lowers the likelihood that consumers choose a high-welfare pork cutlet (confirmation of HC2), so does the increasing duration of transport to the abattoir. One hour additional transportation time lowers the willingness to pay by 20 eurocent per kilogram pork cutlet. In contrast, confirming hypothesis HC1, all FAW program requirements that are assumed to enhance animals' wellbeing are positively valued by consumers. The attribute "no surgery" increased the likelihood of choosing a high-welfare pork cutlet. This result is not in line with Lagerkvist (2006) and Liljenstolpe (2008) who argued that the risk of boar taint leads to a negative valuation of the attribute "no castration". In our study, castration and tail docking are summarized under the term "surgery" hence the single effect of the avoidance of castration could not be clearly identified.

¹⁶ The rich specification includes all exogenous variables whereas the parsimonious specification omits 24 insignificant variables based on a robust Wald test (χ^2 -value is 30.86 with $\alpha = 0.1579$). The McFadden pseudo R^2 of the parsimonious specification is 0.22916. A likelihood ratio test of the rich model against the parsimonious model failed to reject the latter specification (χ^2 -value = 32.71; Prob > χ^2 = 0.1103).

¹⁷ The confidence intervals and significance levels of the WTA were computed using the delta method (Hensher and Greene 2003) which is a common approach in discrete choice modeling (Hole 2007).

Table 4.5 Estimation results from the RPL model, WTP and WTP confidence intervals

Consumer Model N = 629				
Parsimonious model		Coefficient	WTP	WTP confidence
Log-Likelihood value: -5094.0078		(SD)	[€/kg]	interval
				(2.5%; 97.5%)
Attributes of FAW program x	Price for pork cutlet	-0.393*** (0.018)		
	Barn area per animal (m ²)	0.857*** (1.574)	2.18	[1.71; 2.65]
	Straw bedding (part of barn area)	0.564*** (0.9509)	1.43	[1.06; 1.81]
	Straw bedding (full barn area)	0.582*** (0.922)	1.48	[1.11; 1.85]
	Three pieces of manipulable material	0.303*** (0.597)	0.77	[0.41; 1.13]
	Manipulable material plus material for rooting	0.186*** (0.250)	0.47	[0.13; 0.81]
	Surgery with anesthesia	1.085*** (1.525)	2.76	[2.29; 3.22]
	No surgery	0.305*** (1.749)	0.78	[0.32; 1.23]
	Duration of transport (hrs.)	-0.080*** (0.325)	-0.20	[-0.31; -0.10]
Socio-economic variables, consumption-related variables and FAW-relevant variables z	Frequency	-0.288***	-0.73	[-1.05; -0.42]
	Self-service counter	-0.480***	-1.22	[-1.87; -0.57]
	Priority price	-1.141***	-2.90	[-3.59; -2.21]
	Critical attitude	1.253***	3.19	[2.50; 3.87]
	Frequently organic	0.331*	0.84	[-0.07; 1.76]
	Never organic	-0.985***	-2.50	[-3.20; -1.81]
	Consumption decreases	-0.270*	-0.69	[-1.34; -0.03]
	Gender	0.407***	1.04	[0.40; 1.67]
	Interaction: Expenditure on food*two person household ¹⁸	0.116***	0.30	[0.10; 0.49]
	Interaction: Expenditure on food*Family (>2 persons) ⁶	0.131***	0.33	[0.15; 0.52]
	City	0.278*	0.71	[-0.01; 1.42]

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

For cutlet from pigs which are kept in a barn with straw bedding, consumers are willing to pay a mark-up, ranging from 1.43€/kg to 1.48€/kg depending on the size of area that is straw-bedded. Relatively high premiums are paid for an increase in barn area per animal (2.18€/kg for each additional square meter) and surgery with anesthesia (2.76€/kg). The higher WTP value for surgery with anesthesia compared to no surgery might be due to the increased risk of boar taint. Only a slight difference of 0.3 €/kg is shown between the mark-up for manipulable material with additional material for rooting and three different pieces of manipulable material.

¹⁸ Expenditure on food was measured as categorical variable ranging from 1 to 6 with 1 = less than 100€ per month, 2 = 100 to 200€ per month, 3 = 200 to 300€ per month, 4 = 300 to 500€ per month, 5 = 500 to 700€ per month and 6 = more than 700€ per month.

Effects of consumer characteristics show a more nuanced picture. More frequent consumption of pork decreases the probability that consumers choose a high-welfare pork cutlet, reflected by a lower WTP of 0.73€ per kilogram of pork cutlet. As indicated by the negative WTP values, individuals who prefer to buy meat over the self-service counter, who attach a greater importance to price than to brand, origin or taste of a cutlet and never consume organic products (inverse of hypothesis HC3 and HC4) are less likely to buy a FAW pork cutlet. In contrast, high-welfare pork cutlets can be sold at a premium of 3.19€/kg to individuals who regard the current conditions of animal husbandry more critical than the average consumer. In households with two persons and also family households with more than two persons, the increasing share of income spent on food results in a positive WTP of around 0.30€/kg pork cutlet.

The choice experiment with the farmer sample yielded a total of 1120 choices between different FAW programs or the QS minimum standard. From the 140 pig farmers, 12 (9%) were always willing to participate in a FAW program, whereas 32 (23%) farmers never chose one of the proposed programs. Ninety-six (68%) farmers chose a FAW program only in some situations, but not in all. Table 4.6 shows the estimation results of the producer model. In a first step, a model was estimated including all variables. Afterwards, insignificant variables were omitted step-wise¹⁹ from the model resulting in a parsimonious specification. Although not all of the remaining variables turned out to be significant, they were kept in the sparse estimation, since they contribute to the overall model fit.

Of the attribute variables, only the price mark-up has a positive sign (confirming HP1). Conversely, additional barn area and bedding straw lowers the probability of choosing a FAW program (confirming HP2 and HP3). Regarding potential costs arising from reconstruction of farm buildings (e.g. straw storage area, manure tray), the relatively high compensation of 1.72 €/kg carcass for covering the entire barn area with straw seems plausible. The use of straw is often associated with important disadvantages: it requires additional labor input, is often assessed as less hygienic and is incompatible with manure drainage systems.

Other program attributes had no effect on the choice probability. Requirements on surgery such as tail docking and castration, the provision of manipulable material and limited duration

¹⁹ The rich specification includes all exogenous variables whereas the parsimonious specification omits 13 insignificant variables based on a robust Wald test (χ^2 -value is 8.54 with $\alpha = 0.383$). The McFadden pseudo R^2 of the parsimonious specification is 0,35419. A likelihood ratio test of the rich model against the parsimonious model failed to reject the latter specification (χ^2 -value = 4.44; Prob > χ^2 = 0.8150).

of transports to abattoirs had no consequences on the likelihood of program adoption. Calculations based on data from the Chamber of Agriculture (LKSH 2013) showed that the required compensation exceeds the forgone profits due to requirements on stocking density and bedding with straw²⁰.

From the lower section of Table 4.6 it can be seen that also farm and farmer characteristics have an impact on choices. Older farmers are *ceteris paribus* more likely to participate. It might be that those farmers are more experienced than their younger counterparts and thus adapt to changes in farm management more easily. The longer respondents expect to remain active farmers and the more they are willing to invest in the pig farming enterprise, the higher is the probability to join a FAW program. The increased likelihood of program participation for farmers who keep suckler cows is not easy to explain at a first glance. In our sample only five farms keep cows for feeding their calves. These farms are also active in other fields, such as beef fattening and crop growing, but they keep on average 1450 pigs and report a farm size of 74 hectares. Assessing the image of agriculture among the public as relatively negative, these farmers might be especially interested to participate in a FAW program to communicate that they are concerned about their animals. Direct marketing of meat to consumers has also a positive effect on farmers' program acceptance, indicating that those farmers aim to present a good image of pig farming (confirming HP4). In contrast, the number of fattening units decreases the likelihood of participation. With every additional fattening place, farmers need to be compensated with 0.002 €/kg carcass weight. Furthermore, it is self-evident, that farmers' who are opposed to the introduction of a FAW label are less inclined to join such a program.

²⁰ These calculations are available on request.

Table 4.6 Estimation results from the RPL model, WTA and WTA confidence intervals

Producer Model N = 140 Parsimonious model Log-Likelihood: -715.09218		Coefficient (SD)	WTA [€/kg]	WTA confidence interval (2.5%; 97.5%)
Attributes of FAW program x	Price premium	2.318***	-	
	Barn area per animal (in m ²)	-3.079***	1.33	[0.40; 2.25]
	Straw bedding (part of barn area)	-1.845***	0.80	[0.26; 1.33]
	Straw bedding (full barn area)	-3.994***	1.72	[0.53; 2.91]
Farm structure variables attitudinal and socio-economic variables z	Age	0.048***	-0.02	[0.04; 0.002]
	Farm acreage	0.002	-	-
	High education	-0.282	-	-
	Basic education	0.360	-	-
	Fattening units	-0.0002*	0.0001	[-0.00002; 0.0002]
	Willingness to invest	0.009	-	-
	Keeping suckler cows	1.933**	-0.83	[-1.71; 0.05]
	Direct marketing	1.159*	-0.50	[-1.12; 0.12]
	Willingness to participate in a program	0.017	-	-
	Time remaining in business	0.062***	-0.03	[-0.05; -0.003]
Attitude towards animal welfare label	-1.105***	0.48	[0.15; 0.80]	

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

Comparison of willingness to pay (WTP) and willingness to accept (WTA) values

For a comparison of consumers' WTP and farmers' WTA of enhanced animal welfare, a price that can be obtained by farmers is calculated under the assumption of constant mark-up pricing. This means, that if consumers are willing to pay a mark-up about ten percent of the reference price (7€/kg), the producer price (1.70€/kg) consequently increases by ten percent (*ceteris paribus*). Furthermore, approximately only one third of the pork carcass is marketed as fresh pork and the rest is marketed to consumers in cured forms (as sausage, ham or luncheon meats) and for example used for the production of gelatin, where it is not possible to secure price mark-ups.

The producer price that can be paid to the farmer based on the additional consumers' WTP is therefore calculated as:

$$(4.5) \text{ Price for high welfare pork } \left(\frac{\text{€}}{\text{kg}}\right) = 1/3 * \frac{1.70\text{€}}{\text{kg}} * WTP_{total} / \frac{7\text{€}}{\text{kg}} + 2/3 * 1.70$$

Another assumption of this calculation is that consumers are also willing to pay a mark-up for FAW pork from other meat parts. A comparison of required producer prices and prices that can be obtained based on consumers' WTP is presented in Table 4.7. For each FAW measure required producer prices and prices consumers are willing to pay are compared. Assuming that the additional price mark-ups (in percent) can be directly added to the producer price allows the calculation of a "possible" producer price. From Table 4.7 can be seen that consumers would pay on average the highest premium for a barn area of 2.00m² per pig, whereas they are willing to pay a relatively low increment for a barn area of 1.33m² per pig. It is particular notable that the prices pig farmers require exceed the prices calculated based on consumers' WTP without exception. It has to be considered, that these prices are calculated at the mean of both samples and neglect varying WTA and WTP estimates.

Table 4.7 Comparison of required compensation prices and possible producer prices

Variable of FAW program	Required producer price per kilogram pork [€/kg] ²¹	Possible producer price [€/kg]	Additional WTP [%]	Possible consumer price [€/kg] (WTP _{total})	WTP [€/kg]
Barn area of 1.33 m ² per pig	2.14 >	1.87	10%	7.73	0.73
Barn area of 1.66 m ² per pig	2.58 >	2.06	21%	8.45	1.45
Barn area of 2.00 m ² per pig	3.03 >	2.33	31%	9.18	2.18
Straw bedding (part of barn area)	2.50 >	2.05	21%	8.44	1.44
Straw bedding (full barn area)	3.42 >	2.06	21%	8.48	1.48

²¹ The required producer price is calculated by adding the reference price of 1.70 Euros per kilogram the required WTA for the corresponding FAW measure. The marginal WTP for an additional square meter of barn area was divided by three to obtain the marginal WTP for 0.33 m² additional barn area. For example, the required producer price of keeping pigs on a barn are of 1.33 m² per animal, the farmer wishes to obtain 1.70€/kg + (1.33/3) = 2.14€/kg

To take heterogeneous preferences into account, individual WTP/WTA values are calculated according to Breustedt et al. (2013), as the sum of the marginal WTP/WTA (obtained from formula 4.4) values for a program attribute x or a socio-economic characteristic z_n multiplied by the level of the respective variables²².

$$(4.6) \quad WTP \text{ or } WTA \text{ for } n_i = \sum_{j=1}^J \frac{\Delta WTP \text{ or } \Delta WTA}{\Delta x_j} * x_{jni} + \sum_{m=1}^M \frac{\Delta WTP \text{ or } \Delta WTA}{\Delta z_m} * z_{mn}$$

Formula 4.6 allows estimating individual WTA for each pig farmer given the requirement of a clearly defined FAW program. As a result, for each pig farmer an individual WTA of a program with defined requirements can be computed. Likewise individual consumer WTP estimates can be derived for a pork cutlet produced in accordance with certain program requirements. These estimates were used to simulate supply and demand curves for different FAW programs.

Market simulation of supply and demand for pork from a FAW program

To simulate a market for pork produced in accordance with defined FAW program attributes, quantities of supply and demand the sample had to be extrapolated to cover the whole German market. The farms in the sample provide a total capacity of 204.713 fattening places (on average 1462 fattening places), indicating that they are managed intensively compared to the German average of 501 fattening places (DBV 2014). Assuming average numbers of 2.89 fattening rounds per year and an average carcass weight of 95 kg (LWK SH 2013) a total production of 18.7 million kilogram fresh meat is computed. Based on the annual consumption of 738 million kilogram fresh pork in Germany (AMI 2013), the production quantity of the sample represents 2.5% of total demand. Neglecting foreign trade activities, the production quantity of each farmer was multiplied by the factor 39.5 to approximate total production. A similar approach was applied to the consumer sample. From the information on consumption frequency per month²³, the sum of annual consumption days (66 days) was derived for each

²² Dummy variables taking the values one or zero indicating the absence or presence of a certain attribute. In case of numerical variables the marginal WTP/WTA will be multiplied by the standard deviation

²³ The frequency of meat consumption was surveyed in four categories (see Table 4.3). We approximated for each category a number of days per month: 2-3 days/month= 2 days/month; once a week = 4 days/month; several days a week = 12 days/month; daily = 20 days.

household. Taking into account the annual consumption of pork (9.01 kilogram per capita²⁴), a quantity of 0.36 kilogram pork per capita per day was derived. By multiplying this quantity by the number of household members and consumption days per year, a total annual consumption of 18249 kilograms for the whole sample of consumers was calculated. This number represents around 0.0025% of the total consumption in Germany. To predict the market equilibrium for the total German market, the consumption quantities of pork (kg) for each household were multiplied by the factor 40440. Previous calculations led on one side to producer prices based on farmers' individual WTA with corresponding production quantities and on the other side to producer prices derived from consumers' individual WTP with corresponding consumption quantities for defined FAW programs.

For the market simulation four different FAW programs were designed:

- FAW program (entry level): requires a barn area of 1.33m² per pig
- FAW program (medium level): requires a barn area of 1.33m² per pig and straw bedding in a part of barn
- FAW program (high level): requires a barn area of 1.66m² per pig and straw bedding in a part of barn
- FAW program (organic level): requires a barn area of 2.00m² per pig and straw bedding throughout the barn

²⁴ A quantity of 738 million kilogram pork eaten by the German population (81.9 Million people), results in an average consumption quantity of 9.01 kilograms per capita per year.

Because other attributes (manipulable material, surgery and transport duration) had no significant effect on producers' willingness to accept, only requirements on stock density and bedding were taken into account designing hypothetical FAW programs.

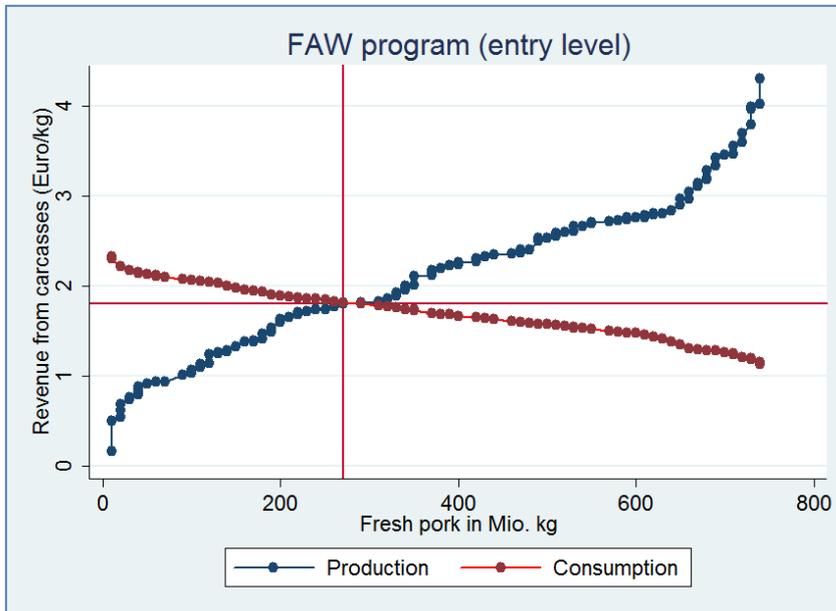


Figure 4.1 Supply and demand for pork in accordance with entry level program

As shown in Figure 4.1 market balance for an entry level program is estimated at 280 million kg of pork meat and a price of 1.80€/kg. This quantity represents 38% of total pork consumption in Germany. Such a low price is only possible because some farmers stated that they are able to produce below the reference price of 1.70€/kg.

In addition to the increased barn space of the entry level program, a medium-leveled FAW program (Figure 4.2) requires bedding straw to be spread in parts of the barn. For this program, market equilibrium is estimated at 145m kg of pork meat, which accounts for 20% of the national pork consumption, and revenue of 2.10€/kg pork meat.

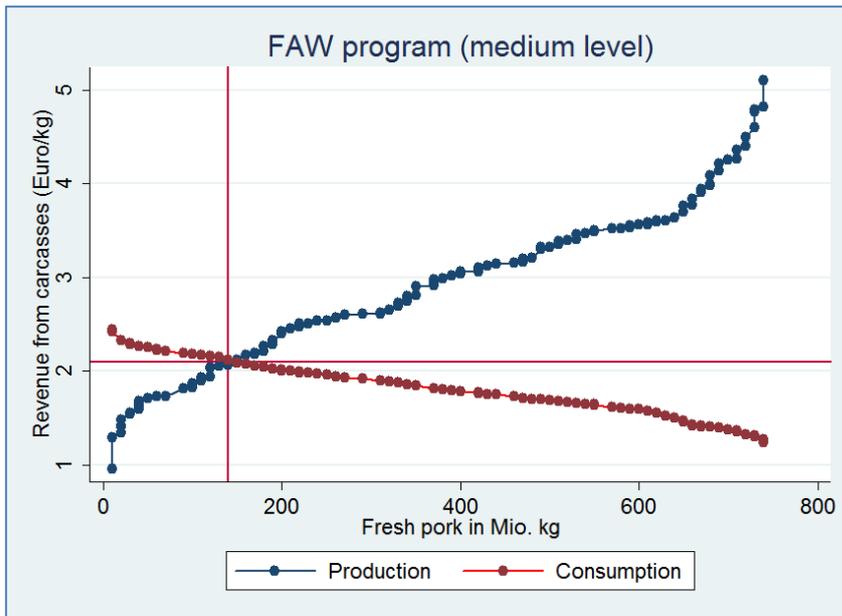


Figure 4.2 Supply and demand for pork in accordance medium level program

The third program (high-level FAW program) depicted in Figure 4.3 represents a higher standard, including 1.66m² of barn space per pig and straw bedding in parts of the barn. The market balances at 90 million kilograms and a price of €2.25 kg pork meat.

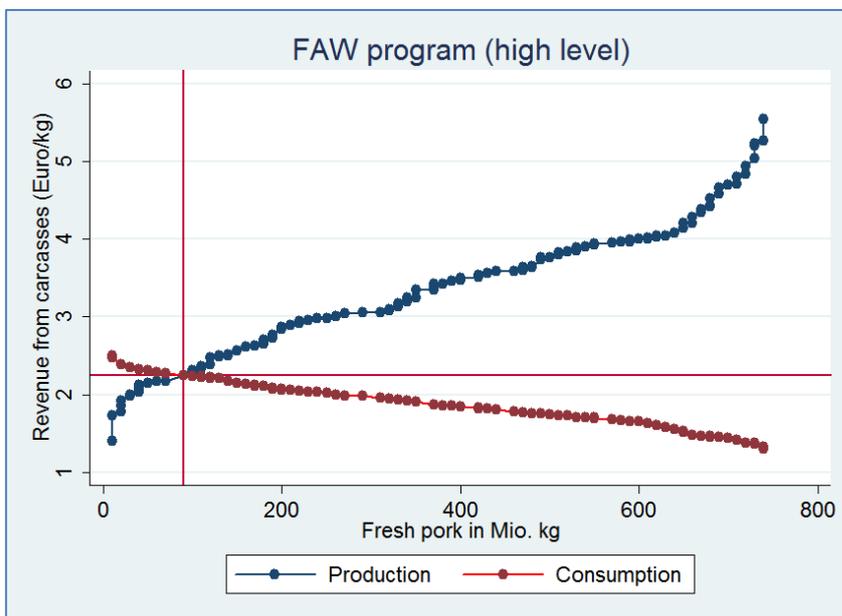


Figure 4.3 Supply and demand for pork in accordance with high level program

A FAW program with requirements similar to organic livestock standards is presented in Figure 4.4. Farmers who aim to participate in this program have to extend barn space to 2.00 m² per pig and cover the entire barn floor with straw.

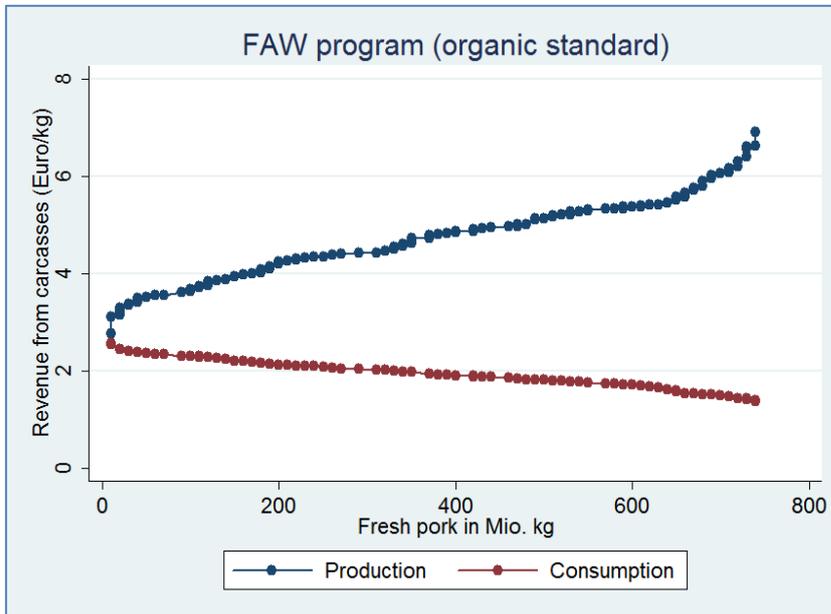


Figure 4.4 Supply and demand for pork in accordance with organic level program

For this program (Figure 4.4), market balance could not be achieved. Producers require revenue ranging from 2.80€/kg to 7.00 €/kg pork meat, whereas prices derived from consumers' WTP were between 1.40€/kg and 2.60 €/kg pork meat. Comparing the pork markets in accordance with varying standards (Figures 4.1 to 4.4) it becomes obvious that supply and demand increasingly diverge with stricter program requirements.

4.6 Discussion and Conclusion

It was found that estimates of consumers' WTP for FAW attributes are all significantly positive. As expected, negative utility was derived for less restrictive limits on transportation time to the abattoir. Previous consumer studies show similar results. For example, Lagerkvist et al. (2006) found that Swedish consumers were willing to pay a 46% mark-up on the reference price when pigs are kept indoors with plenty of straw. The present study supports their result, although the price increment for straw flooring was only 20%. Furthermore, they reported that consumers strongly dislike a ban of castration due to increased risk of boar taint. The present study could not confirm this result, because requirements on castration and tail docking were combined into one attribute "surgery". Pig castration under anesthesia led to a WTP of 39%

above the reference price. Exactly the same result was found by Liljenstolpe (2008). In contrast to the present study, Lagerkvist et al. (2006) reported that females are willing to pay less than men for the use of straw as bedding material, allowing pigs to be outside and fixing sows only at delivery or not fixing them at all. An opposite effect was found in the present study. Instead of gender effects on single attributes, the influence of gender on the probability of purchase was predicted, and it was found that females are more likely than men to buy high-welfare pork. Comparing the results of the producer model with existing studies is difficult. First, studies on farmers' acceptance of farm animal welfare initiatives are more focused on their general attitudes towards such programs (Bock and van Huik 2007; Kirchner et al. 2014) and less on preferences for certain requirements. Second, existing discrete choice studies with livestock farmers deal with voluntary checkoff programs (Norwood et al. 2006), traceability systems (Schulz and Tonsor 2010) and marketing contracts (Roe et al. 2004) and thus investigate different choice attributes. Nevertheless, some aspects found in previous studies can be confirmed by this research. For example, the impact of a positive attitude towards a farm animal welfare label on farmers' participation in a program supports the findings of Vanhonacker et al. (2008). They found that some farmers are interested in establishing a more positive image of agriculture among the public.

The present study has shown that farmers, who are generally willing to accept a FAW program, require on average a price increment above what consumers are willing to pay. To account for differences among respondents, individual WTP and WTA values were calculated. The market simulation based on these values showed a more differentiated picture of supply and demand relationships for pork produced under different hypothetical animal welfare programs. Standards that are slightly above the QS minimum standard (FAW entry level presented in Figure 4.1) are well accepted and potentially cover a market share of 38%. Programs that are more restrictive on stock density and require straw bedding generate only smaller market potentials. This development can be explained by an increasing divergence between what farmers require for implementation of higher FAW standards and what prices consumers are willing to pay. It is emphasized that market simulations are made under restrictive assumptions regarding the extrapolation of estimation results to the German pork market. Another drawback of the present study is that the empirical analysis is based on two samples that are not representative of the total population. This means that the conclusions drawn are tentative and must be regarded with caution.

This paper aimed to shed light on pig farmers' acceptance higher FAW standards and furthermore, on consumers' willingness to pay for pork produced in accordance with such standards. Discrete choice experiments (DCE) using identical choice sets were carried out with both consumers and pig farmers in Germany. From the results it can be concluded that some consumers are indeed willing to pay a premium for FAW in pork production. Especially the use of anesthesia for surgery is highly valued. Immuno-castration might provide an alternative and should be considered as attribute in further preference studies. Furthermore, not all farmers are equally responding to FAW programs. In particular, farmers who communicate their concern for animal welfare to consumers through direct marketing can draw some benefit from such programs. From both samples only a minor share of 9% were unwilling to consider trade-offs between attributes and, in turn, always refused to choose a FAW program over the minimum standard. Existing programs such as the oversubscribed *Initiative Tierwohl* show that, in practice, many farmers are ready to take part in animal welfare initiatives. It remains to be seen whether the increasing supply of FAW through such initiatives is met by consumers demand. The low share non-purchases in the present study (21% of all choices) must be seen in the light the attitude-behavior gap, and time will tell whether this low share is only an artefact of the survey's hypothetical nature.

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Chapter 5

Dairy farmers' support of horizontal cooperation among dairy processors: conceptual model and empirical testing

Authors

M.Sc. Tim Viergutz, M.Sc. Julia Anette Schreiner and JProf. Birgit Schulze-Ehlers

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Abstract

Small dairy cooperatives can improve their economic performance through horizontal cooperation, e.g., joint milk collection. The approval of such a strategy by cooperative members, however, is at risk given an increasing erosion of collective action commitment documented in the literature. This paper aims to explain members' decision to approve or disapprove of dairy cooperatives' joint milk collection. We draw not only on economic theory, but also include psychological and sociological logics. Farmers' decisions are modeled by means of a discrete choice experiment. Relevant attitudes and relationship quality are measured using extant scales. The model is then tested on data collected from members of two dairy cooperatives. A multinomial logit (ML) regression is performed to explain farmers answering patterns, where we distinguish between always supporter, selective deciders, and never supporters. The multinomial logit regression to explain farmers' specific response behavior to the proposed alternative optimization models in the DCE reveals that especially the never- and always-supporters can be meaningfully distinguished by their levels of social interaction with other members, supplier relationship quality with the cooperative, and attitude towards the project. Frequent cooperative member interaction and supplier relationship quality are both associated with an increase in the relative-risk ratios of belonging to the group of never supporters, whereas attitude towards project and attitude towards climate change are associated with a decrease in the relative-risk ratios of belonging to that group. Overall, the study highlights the necessity to take into account farmers' attitudes towards proposed strategies, but also their relationship with the cooperative, in order to predict and influence their decisions. For the latter, this study provides insights as to the relevance of social interaction among members, which could be exploited through skillful member management.

Keywords: trust, social interaction, spatial dispersion, member relationships, cooperatives

5.1 Introduction

The European dairy sector is under pressure. Recent developments, such as changes in policies, high price volatility in global markets, new regulations, altering consumer preferences and an increasing demand for animal feed left European dairy farmers in a more competitive market with more volatile returns and increasing costs. To cope with this financial stress, dairy farmers need efficient and well-performing partners in the dairy processing industry easing their situation (Soboh et al. 2011).

However, the dairy supply chain is often characterized by power imbalances (Jansik et al. 2014). This holds especially for Germany. With a highly concentrated retail sector exerting bargaining power over upstream suppliers, cost pressure is high, resulting in ongoing structural change at the processing and farm level (Jansik et al. 2014). Geographically, there are huge differences in the German dairy industry, with regard to the structure and overall strategy of processing companies. While the South is characterized by mainly privately owned processors producing higher-priced goods in smaller factories, dairy companies in the North-Western region are for the most part cooperative enterprises (Zieseniß 2014), often with a focus on larger processing quantities and bulk commodities such as milk powder, butter, or low-priced consumer goods such as UHT milk (Jansik et al. 2014). However, in the Federal State of Schleswig-Holstein, with about 5,000 dairy farmers, there are still 16 dairy processors, of which most have between 100 and 150 suppliers only. As shown by Zieseniß (2014) in an analysis of dairy companies' earning indicators, cooperatives often have disadvantages when compared to investor-owned firms. Although this can be explained with the specificities of the legal form, it poses a general threat to cooperative enterprises that have difficulties financing long-term investments (Nilsson 2001). Since large cooperatives are able to realize economies of scale and scope, smaller cooperatives may face additional disadvantages compared to their large competitors. Cooperation among smaller cooperatives could remedy these drawbacks (Pesämaa and Hair Jr 2007). However, such strategies must normally be approved by the cooperative members, who may neither be homogeneous in their individual interests nor agree with the management's positions. Recent research has shown that there are increasing difficulties in aligning members' and boards interests (Cook 1994; Österberg and Nilsson 2009). These strains between processing cooperatives and their member bases have strongly increased in Germany in the past decade. A milk strike (delivery boycott) in 2008 underlines the tense situation. There is also empirical evidence from many countries, including Germany,

for the overall heterogeneity of farmers' perceptions of their buyers' strategies (Kalogeras et al. 2009; Hellberg-Bahr et al. 2011). This may thus be a crucial barrier to horizontal cooperation of dairy processors, and particularly cooperatives, despite anticipated cost-reductions.

The aim of this paper therefore is to gain a better understanding of determinants of farmers' approval or disapproval of their cooperatives' strategy. To this end, a theoretical model is developed which combines various research streams, including economics, psychology, and sociology. The model is tested in an exploratory empirical survey among dairy cooperative members in Northern Germany.

Our approach is innovative both in the inclusion of measures of social interaction and spatial proximity, as well as in the methodological approach, employing discrete choice analysis to elicit farmers' willingness to support their cooperatives' strategy. We furthermore use an innovative empirical example, i.e., a project aiming at a joint optimization of dairies' milk collection logistics, where economic and ecological benefits are achieved simultaneously, but farmers may have to accept that their milk is collected and processed by another dairy company of which they are not a member. In the next section, the project will be described in more detail, before we develop the research model, describe material, methods, and results and end with a discussion of and conclusions on theoretical and managerial implications.

5.2 Cost reduction through collaboration in milk collection

The food processing industry often faces high transportation costs in sourcing, due to the fact that suppliers are spatially dispersed and raw agricultural products often are bulky and/or perishable (Sexton 1990). This holds especially for the dairy market with the perishable milk being collected with a relatively high collection frequency (in most cases every other day), resulting in catchment areas that allow an economically reasonable acquisition of the raw milk (BKA 2012). Boysen and Schröder (2006) state that the importance of transportation costs relative to other cost factors will increase in the future because of developments such as increasing fuel costs, road charges or environmental regulations. Since farmers in Germany mostly receive the same price irrespective of their spatial location and thus irrespective of the relative costs of milk acquisition, processors bear the total costs of transporting the raw product from the farmer to the processing site (BKA 2012). Thus, cost reduction in milk acquisition is desirable and could be achieved by cooperation among processors (BKA 2012). Boysen and Schröder (2006) describe relevant returns to scale with regard to growing processor sizes. The specific potential for smaller cooperatives located in the same area lies in joint

milk collection such that each farmer's milk is transported to the closest dairy, instead of the dairy to which the farmer is associated as a member. As exemplified in Figure 5.1 for the case of two dairies A and B and their suppliers A1-5 and B1-4, this would mean that the milk of farmers A2 and A5 would likely be more efficiently collected by the milk truck of dairy B, while B3 and B4's milk would be processed in dairy A. Membership and payment would not be affected by this logistics optimization, since the processors would settle the transfer between them without notice to the farmers. Cost savings would be shared according to the contributions of each dairy.

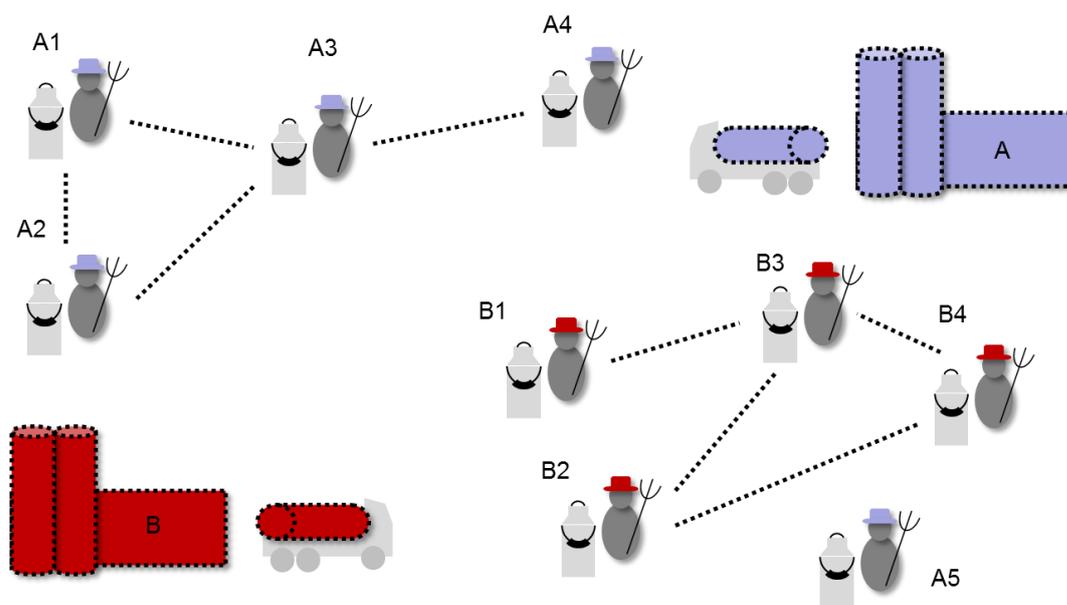


Figure 5.1 Exemplary case of dispersed member structures and individual milk collection

Besides the organizational requirements, there is an additional challenge to the implementation of such cooperation, since the support of the members cannot be taken for granted, as we will explain in the following section.

5.3 Farmers support of cooperative management strategies: Development of the research model

The cooperative model implies the role of farmers not only being patrons but also owners. With the democratic principle of one man-one vote, this demands farmers' involvement in decision-making. Several studies have pointed at increasing difficulties of cooperative enterprises to make their members engage in active participation (Nilsson 2001; Nilsson et al. 2009; Österberg and Nilsson 2009; Nilsson et al. 2012). Furthermore, there is evidence of a gap between managers, the board of directors, and members with respect to the evaluation of

strategies (Hellberg-Bahr et al. 2011). Consequently, members' support of the cooperatives' strategies as developed by the CEOs can be at stake. In this section, we first elucidate the approach to assess farmers' overall propensity to support management strategies and thereby set the theoretical framework. We then explore the state of knowledge in the field of farmer participation in cooperative decision-making, and develop our research model to explain farmers' acceptance of a stronger collaboration among their cooperative enterprises. Hypothesized determinants include the evaluation of the strategy, or project, the quality of the farmer-cooperative relationship, and the local and social interaction among members, i.e., the farmer-farmer relationship.

Assessment of farmers' propensity to accept management proposals

Assuming farmers to be rational, utility maximizing actors, one would expect that farmers support those strategies that they await to lead to the best possible outcome. Since utility is a latent construct that cannot be measured directly, we make use of the discrete choice approach, based on Lancaster's characteristics theory of value (Lancaster 1966), which allows us to assume that farmers' acceptance of a proposed strategy depends on the evaluation of the "bundle" of measures and their consequences.

From a set of mutually exclusive and finite milk collection schemes, farmer n choose the most preferred one (j^*) yielding the highest utility (U_{jn}). Following the random utility theory (McFadden 1974), farmers' decision process is not observable by the researcher and therefore the utility function is understood to comprise two parts

$$(5.1) \quad U_{jn} = V(x_{jn}, z_n) + \varepsilon_{jn}$$

with V being the deterministic part defined by a vector of attribute levels \mathbf{x} , a vector \mathbf{z} defined by the farmers' personal characteristics, and ε being the unobservable stochastic part accounting for information that is not captured by the model. The deterministic part gives us the framework for the research design.

There are to date a number of studies employing discrete choice experiments (DCE) to explain farmers' preferences. Examples include contract acceptance (Roe et al. 2004; Broch and Vedel 2012), acceptance of changes in production practices like the adoption of GM seeds (Breustedt et al. 2009) or the effect of abandoning the use of bovine growth hormones in milk production (Olynk et al. 2012). Previous studies have shown the use of DCE as a tool to investigate drivers for contract acceptance. For example Roe et al. (2004) investigated hog pro-

ducers' preferences for marketing contract attributes affecting the distribution of profits. Besides the effect of contract elements on the likelihood of acceptance they revealed strong preferences for a cooperative organizational form, in particular for producers who attach importance to a trustful relationship with their contractors. In their study of participation in agri-environmental schemes (AES) Ruto and Garrod (2009) identified a large group of farmers who require a lower incentive payment for acceptance of contracts that offer less flexibility and a higher administrative burden compared to a group of highly resistant adopters. In a study on afforestation contracts Broch and Vedel (2012) investigated farmers' preferences for attributes composed of the purpose of afforestation, a cancelling option and monitoring of implementation as well as a compensation payment. They emphasized the importance of accounting for heterogeneity among the target population to design contracts efficiently. Overall, these studies highlight that information on farmers' valuation of contract elements is key to achieve a higher level of acceptance.

In the cooperative literature, however, we are not aware of any study employing discrete choice experiments to investigate farmers' support for their cooperatives' strategy conditional on the level of expected outcomes. For the logistics optimization presented above, we suggest that a DCE can be employed to measure farmers' approval of the optimization scheme. We assume that farmers' decision behavior depends on the expected savings, redistributed to the farmers as a mark-up on the milk price and a reduction in carbon emissions due to reorganization of milk collection (Quinlan et al. 2012), and the need for a farmer to accept that his milk be collected and processed by another dairy. The following hypotheses are related to these attributes (x):

H1: The higher the economic gain from the scheme, the more likely a farmer will approve it.

H2: The higher the reduction in carbon emission associated with the scheme, the more likely a farmer will approve it.

H3: If the optimization scheme requires a farmer to accept his milk being processed in another dairy plant, he will be less likely to approve of the scheme.

In the following, we explore the personal characteristics (z), which we assume to additionally shape farmers' preferences.

Evaluation of the strategy

Hellberg-Bahr et al. (2011) use a psychometric approach to measure farmers' evaluation of particular cooperative strategies. They find, based on attitudinal measures, that there are basically two groups of farmers: those who are rather short-term oriented, and those who support investments of their dairy cooperative which will pay-off in the longer term. Although a link to the actual decision-making of farmers is not made, one can assume, following the Theory of Planned Behavior (Ajzen 1991), that such attitudes are strongly related to intentions to act. We therefore hypothesize that

H4: The more positively a farmer evaluates the proposed strategy of cooperatives' managers, the more likely he will support it with his vote.

In addition to the economic benefits which can be derived from the cooperation, in the specific case of logistics optimization, there are further positive effects relating to a reduction in CO₂-emissions (Sheane et al. 2011; Thoma et al. 2010). We therefore hypothesize that

H5: The more a farmer fears the consequences of climate change, the more he will be willing to support the logistics optimization.

Quality of the farmer-cooperative relationship

Reasons for the differences in perceptions, expectations, attitudes and actions among members as well as between members and management, or the board of directors, respectively, have been extensively described in the literature. Specific aspects to be noted are: common ownership (free-rider), horizon, portfolio, follow-up, and decision-making problems, which are fundamentally based in member heterogeneity and diluted property rights (Nilsson 2001; Cechin et al. 2013). Large cooperatives often also suffer from an increasing social alienation from their members, when personal relationships become difficult to maintain with a growing member base. This might cause additional problems in the relationship between members and their cooperatives. Empirical evidence in the relationship management literature underlines that specifically trust and commitment have a positive impact on, among others, willingness to cooperate (Morgan and Hunt 1994; Wilson 2000; Kleinaltenkamp et al. 2006; Cechin et al. 2013) Such effects have been proven in many empirical studies also in the dairy sector (Schulze et al. 2008; Schulze-Ehlers et al. 2014).

Relationship quality is generally understood to comprise satisfaction, trust, and commitment, although many studies also include other variables such as communication (Athanasopoulou 2009). Some studies exclude satisfaction (Obadia and Vida 2011; Leonidou et al. 2014), while others only retain satisfaction out of the three core variables and include other measures instead (Lages et al. 2005). Hellberg-Bahr et al. (2011) find that relationship quality plays an important role in explaining farmers being in the cluster of “investment supporters” in a cooperative context. Österberg and Nilsson (2009) as well as Hansen et al. (2002) and Cechin et al. (2013) also provide evidence for the positive effects of trusting member-cooperative relationships on loyalty.

In the specific case of milk collection optimization, where the actual savings occur at the processor level and may strongly differ based on the regional conditions (Quinlan et al. 2012), farmers have to trust their cooperative to honestly reveal the financial gains and redistribute it to them as members. Put differently, the lack of transparency of the monetary effects and consequently the lack of means to fully appropriate the savings requires members to either trust their dairy or disapprove of the measure (Schulze-Ehlers et al. 2014). On the other hand the strategy might imply that a member is required to accept his milk being processed in another dairy. For this case, it can be assumed that a very trusting and committed member also would disapprove. It could thus be anticipated that

H6: There is an inverse U-shaped effect of relationship quality on farmers' propensity to support milk collection optimization, with very high and very low relationship quality leading to disapproval of the optimization project.

Local social interaction as a determinant of group cohesion and cooperation orientation

It is straightforward to assume that factors such as communication between member and coop, or the behavior of the management and the board of directors can have a direct effect on relationship quality (Wilson 2000; Hansen et al. 2002). Another, more sociological perspective, lets us introduce also member-member-interaction into our empirical model explained below in this section. Hansen et al. (2002) explored the effect of trust among members of two agricultural marketing cooperatives on their perceived cohesion, and consequently willingness to stay with the group, i.e., the cooperative. A major finding is that trust varies depending on the complexity of services offered and the geographical dispersion of the cooperative members. They hypothesize that the latter might be an indicator of the infrequency of social interactions among members and between members and management, which results in lower levels of

affective trust as compared to cognitive trust (Hansen et al. 2002). The main justification is that geographical dispersion leads to less frequent interactions and thus fewer personal relationships among members or between members and management, which are a prerequisite for the formation of affective trust. The cooperative therefore cannot represent a means to fulfill social goals if its membership is strongly dispersed (Hansen et al. 2002) and cognitive parameters determine loyalty or switching, cooperation or defection.

Theoretically, besides these empirical findings, justification for the inclusion of social interaction is straight-forward. In general, economic agents and their interactions are the core of economics. The actions of one agent potentially affect the preferences, expectations and constraints of other agents (Manski 2000). Therefore, social interaction may shape farmers' preferences, expectations and constraints with regard to the optimized milk collection.

The inclusion of social interaction seems even more reasonable in a cooperative setting, because the cooperative is a network organization by design (Hong and Sporleder 2007), comprising social interaction and clan-like structures (Ouchi 1980). Whereas the outcomes of social interaction, such as social capital in cooperatives, are commonly considered (for example Nilsson et al. 2012), direct inclusion of social interaction in agricultural research is rare. Exceptions include the examination of social effects influencing the learning and adoption of new technologies and practices (Foster and Rosenzweig 1995; Conley and Udry 2010; Yu et al. 2014). Doing so, however, requires defining the group of people (peers) somebody is influenced by with regard to a certain issue. In a cooperative setting, this may be rather complex, since one may consider social interaction with different groups, e.g. cooperative members, non-cooperative members, the cooperative management and others.

Taking up the consideration that frequent social interaction between cooperative members results in higher levels of affective trust, leading to higher levels of group cohesion (Hansen et al. 2002), one may assume that members interacting mostly with other members will be more reluctant to approve cooperative measures they fear to threaten that structure. On the other hand, if someone is characterized by high levels of interaction with the members of other cooperatives, his social network is less associated with the cooperative, leading to less perceived dependence of the cooperative as a means to fulfill social goals.

This leaves one with the next hypothesis:

H7: Frequent interactions with coop members result in a lower willingness to support the cooperatives' measure.

Furthermore, the conclusions by Hansen et al. (2002) are based on the assumption of spatial proximity as an indicator for the frequency of social interaction. This link has been empirically tested in various networks and contexts (Sohn et al. 2013), but, to our knowledge, not in the framework of agricultural cooperatives. The last hypothesis therefore is:

H8: Social interaction is associated with spatial proximity in an agricultural cooperative context.

Figure 5.2 summarizes the theoretically evaluated determinants of the approval of horizontal cooperation.

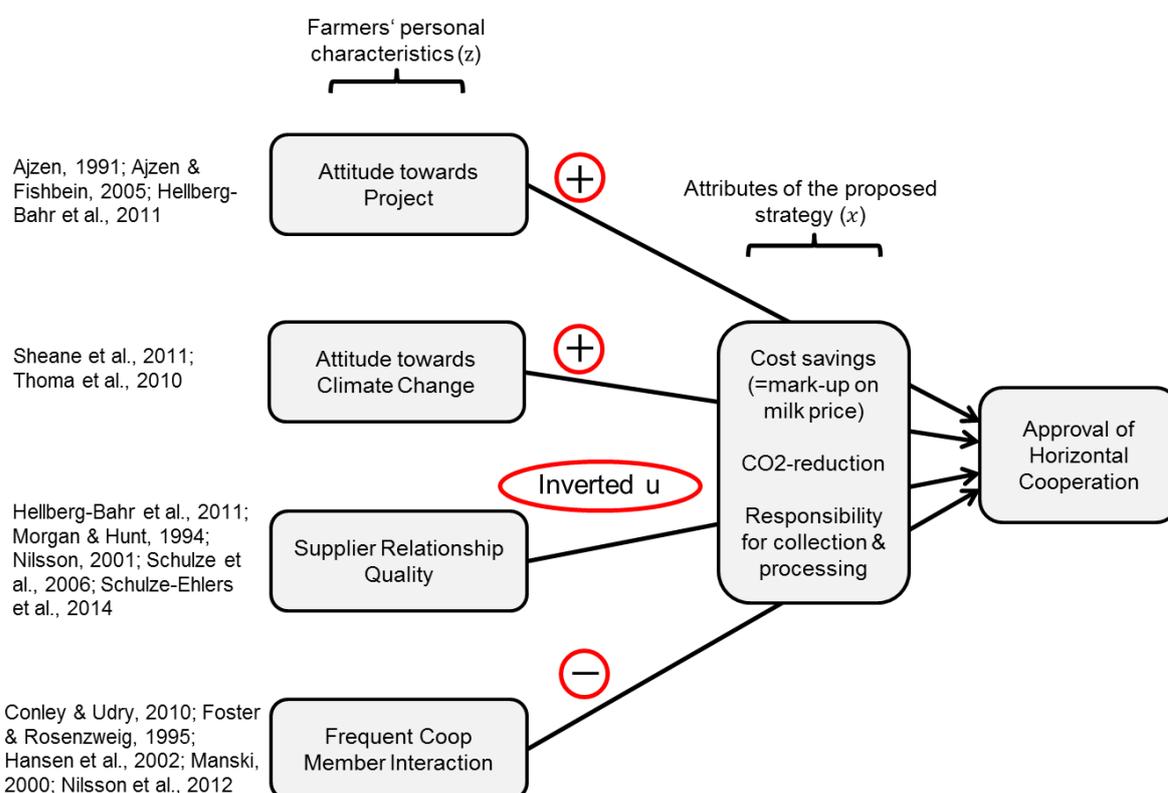


Figure 5.2 Proposed Research Model

The next section describes the data collection, employed measures, and explains how a discrete choice experiment (DCE) is used to elicit farmers' willingness to support cooperative policies.

5.4 Material and Methods

Data Collection

The distribution of the written questionnaire was managed by two dairy cooperatives in October 2014. Fifty-three questionnaires were returned completed, accounting for 19 % and 21 % of the respective cooperatives' members. Fifty of the 53 respondents indicated being the head of the farm operation. Thirty-six percent of the farmers stated there was another dairy closer to their farm. Fifty-four percent of the participants have been members of the respective coop for more than 20 years, 34% have been members for less than 10 years. The majority (58 %) has a milk quota endowment between 300,000 and 700,000 kilograms, 23 % have more, and 19 % have less than that.

Measures

The attitude towards the proposed logistics optimization was measured with four items asking whether farmers deemed the measure as making sense, the cooperation to be realistic, the opinion of peers with respect to the optimization, and the extent to which the measure is actually relevant for achieving the expected goals, in this case, the contribution of transportation to the carbon footprint of milk. The measures of relationship quality are based on the supplier relationship quality (SRQ) items from Schulze et al. (2008), Hansen et al. (2002) and Bijman and Verhees (2011). To measure supply chain orientation, two items were taken from (Schulze-Ehlers et al. 2014), reflecting vertical cooperation orientation, and common goal orientation. For the empirical case study, attention was also paid to studies dealing with concern for climate change. Arbuckle et al. (2013) recently provided evidence of the heterogeneous attitudes of farmers with respect to climate change. We therefore expect that a farmer will be more willing to support the proposed logistics optimization the more he is concerned about climate change. Four items reflecting concern about climate change and willingness to contribute to climate change mitigation were taken from Arbuckle et al. (2013). The attitudinal and the SRQ items were all measured on 7-point scales. To reduce the complexity and test for the unidimensionality of the included constructs, a principal component analysis (PCA) with an orthogonal (varimax) rotation was employed, with an Eigenvalue of 1 as cut-off criterion. Beforehand, a substitution of missing values by the mean was performed. A maximum of four values per variable were substituted, indicating a maximum share of substituted values per variable of 7.5 %. Table 5.1 presents an overview of the results. The Cronbach's Alpha values of above 0.7 for the factors indicate a sufficient reliability of the factors.

Table 5.1 Results of the PCA

N = 53	Mean	SD	Factor Loading
Construct/ item			
Supplier Relationship Quality			
(Cronbach's Alpha=0.95; contribution to variance explained=36.4%)			
How much do you trust the dairies' management? ²⁵	6.06	1.18	0.922
There is no factual reason to doubt the managements' abilities. ²⁴	6.21	1.03	0.887
My dairy is economically well positioned. ²⁴	6.10	1.10	0.865
How much do you trust the cooperatives' board? ²⁶	5.90	1.11	0.845
I feel well represented by the board. ²⁴	5.92	1.11	0.829
The dairy respect their commitments. ²⁴	6.15	1.06	0.787
My sense of intuition tells me that the cooperative's management can be trusted. ²⁴	6.02	1.22	0.754
If I could choose a new buyer, I would choose the same again. ²⁴	6.13	1.02	0.695
I feel committed to my dairy. ²⁴	6.09	1.15	0.677
The prices paid by my dairy are reasonable considering the different market situations. ²⁴	5.75	1.19	0.670
In case of problems my dairy and I come to an accommodation. ²⁴	6.10	0.99	0.654
Attitude towards Project			
(Cronbach's Alpha= 0.85; contribution to variance explained =14.7%)			
An optimization of milk collection in Schleswig-Holstein is useful. ²⁴	5.23	1.98	0.904
The cooperation of farms in Schleswig-Holstein is reasonable. ²⁴	4.55	1.59	0.852
The majority of my peers believe that an optimization of milk collection in Schleswig-Holstein is useful. ²⁴	4.31	1.92	0.833
Transportation has an impact on the carbon footprint of milk.	4.72	1.78	0.684
Satisfaction with Dairy			
(Cronbach's Alpha=0.87; contribution to variance explained=14.1%)			
I am ... with the milk collection of my dairy. ²⁵	5.71	1.50	0.830
I am ... with the collaboration with my dairy. ²⁵	6.09	1.35	0.757
Compared to other dairies I am ... with my dairies' milk price. ²	5.87	1.36	0.748
Attitude towards Climate Change			
(Cronbach's Alpha= 0.72; Variance explained = 8.6%)			
The possible influence of climate change on our local agriculture worries me. ²⁴	4.21	1.88	0.877
I believe that extreme weather events will occur in the future. ²⁴	4.92	1.73	0.850

²⁵ Scale from 1= Not at all to 7= Entirely

²⁶ Scale from 1 Absolutely dissatisfied to 7= Absolutely satisfied

The overall perceived supplier relationship quality includes ten items covering the sub-dimensions: commitment as well as cognitive and affective trust. The employed items for this construct were adapted from Schulze et al. (2006), Hansen et al. (2002) and Bijman and Verhees (2011). The satisfaction with the relationship however was found to form a separate factor comprising three items relating to the collaboration in general, the milk price and milk collection, as proposed by Schulze et al. (2008). Trust includes both a cognitive and an affective dimension. In the cooperative context, trust in the managers as well as in the board of directors and representatives has to be distinguished. Farmers' attitude towards the proposed project was measured with four items asking whether farmers deemed the measure as sense making, the cooperation to be realistic, the positive opinion of peers with respect to the optimization, and the extent to which the measure actually is relevant to achieve the expected goals, in this case, the contribution of transportation to the carbon footprint of milk. Two items reflecting farmers' concern about climate change were adapted from Arbuckle et al. (2013). All utilized attitudinal and SRQ items were measured on 7 point scales.

As shown by reported means and standard deviations in Table 5.1, perceived relationship quality and satisfaction are quite high in the sample. Also, the evaluation of the project is overall positive, but farmers are rather neutral as to the impacts of future climate change. The 7-point scale is fully exploited by the participants only in the case of project evaluation and climate change perceptions. For satisfaction, the items on overall satisfaction and price satisfaction exhibit a minimum value of 2, thus the most negative answer has not been selected by any of the respondents, and most of the relationship quality items have a minimum value of 3 (exemption: for trust in management the minimum is 2).

Spatial dispersion is measured by the share of neighbors being members of the same cooperative. Measures for social interaction with respect to dairy farming are based on Bijman and Verhees (2011), Conley and Udry (2010) and Yu et al. (2014), distinguishing neighborhood and cooperative membership, respectively. Descriptive statistics of these Likert type items are reported in Table 5.2.

Table 5.2 Results for spatial and social interaction

Items for spatial and social interaction	Mean	SD	Min	Max
How many peers (dairy producers) with who you discuss issues regarding milk production and marketing at least once a month live in your or a neighboring municipality? (N=47)*	4.28	1.56	1	7
How many peers (dairy producers) with who you discuss issues regarding milk production and marketing at least once a month are members of your cooperative? (N=48)*	4.10	1.57	1	7

*Scale from 1= None to 7= All

Those two variables show no tendency, since the mean is close to 4 and the full scale is exploited. The third variable was measured as a binary variable and the respondents had to indicate, whether most of their neighboring dairy producers are a member of their cooperative. It thus indicates the spatial proximity to other cooperative members. Twenty-nine respondents indicated that most of their neighboring dairy producers are a member of their cooperative, whereas 19 respondents negated this question. Table 5.3 shows the distribution of this binary variable in relation to the variable indicating the share of peers being members of the same cooperative.

Table 5.3 Cross table of spatial membership structure and social interaction

“Most neighboring dairy producers are members of the same cooperative.”	“How many peers (dairy producers) with who you discuss issues regarding milk production and marketing at least once a month are members of your cooperative?”							Total
	None					All		
No	3	2	7	5	0	0	2	19
Yes	0	1	3	11	7	4	3	29
Total	3	3	10	16	7	4	5	48

The cross table suggests that farmers who are mostly surrounded by other cooperative members seem to have more social interaction with cooperative members. Given that a Shapiro-Wilk test failed to reject normality and a Bartlett's test for equal variances failed to reject homogeneity of variances we carried out a t-test. This indeed supports H_8 , i.e., we found significant differences in the central tendency (mean: 4.66 vs. 3.26; t-value: -3.295).

Since we hypothesized that frequent interaction with cooperative members has an impact on the willingness to support the cooperative measure, we dichotomized the variable measuring the share of peers being members of the same cooperative. Respondents that quoted higher values than the neutral position (4) are thus grouped by the dummy variable. In doing so, we are cautious of incorporating single-item measures with regard to complex constructs and assume that by means of the dichotomization, the true scale of social interaction is measured with more validity. This new variable indicates a more frequent interaction with cooperative members compared to non-cooperative members and was labeled as frequent coop member interaction.

Discrete Choice Experiment

To investigate acceptance behavior and identify determinants of the decision process prior to project implementation, we employed a discrete choice experiment (DCE). The assumptions underlying this model have already been detailed in Section 5.3. The experiment to elicit the implicit utility of single measures combined in the optimization strategy was set up in close cooperation with two dairy managers. The relevant issues regarding the optimization of milk collection and consequences that might affect the approval by the farmer were carefully discussed. Primarily, the cooperation serves the purpose of efficiently planning the milk collection routes. To achieve cost savings, the collection may be done by a shipping company or by the cooperating firms depending on the distances between farm and processor. The decision parameters relevant for farmers' approval or disapproval of a joint logistics optimization were defined to relate to (1) the potential increase in milk prices due to cost savings, which range between 1 and 10 eurocent/100 kilograms of milk, (2) the consequence for the individual farmer, which could be that a farmer's milk would be collected by an external shipping company or processed by another firm, and (3) the potential reduction of CO₂-emissions, which were estimated to be between 1 and 3 %.

In the DCE framework, different versions of a logistic optimization model are presented to members of the cooperatives. Each choice set comprised two possible optimization models and an "opt-out" alternative if the farmer does not approve the cooperation. Due to the voluntary character of approval the inclusion of the status quo option is deemed realistic. The D-efficiency of the orthogonal design after exclusion of three unrealistic combinations is still high at 98.6 with regard to a value of 90 indicating a satisfactory design (Kuhfeld et al. 1994).

The alternatives were divided into six blocks with four choice sets each. Table 5.4 exemplifies a choice set.

Table 5.4 Example for a Choice Set

Attributes	Model 1	Model 2	Opt-out
Milk collection and processing	Milk is collected by a shipping company and processed by the cooperating firm.	Milk is collected and processed by the cooperating firm.	None of the models is attractive to me.
Reduction of emission	2%	1%	
Compensation (eurocent per 100 kg milk)	1.0	2.0	
I agree to:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Unfortunately, the number of questionnaires per block was not returned equally distributed, implying an unbalanced distribution of choice options in the sample. A first overview of the returned questionnaires indicated a specific response pattern distinguishing three different groups: “never supporters (1)”, comprising ten farmers who never chose one of the proposed models presented in the four choice-sets in their version of the questionnaire, ten “selective deciders (2)”, who supported some, but not all models, choosing at least once to opt out, and 33 highly supportive farmers classified as “always supporters (3)” who always chose one of the proposed models. Following the rationale of Lancaster’ characteristics theory, we can assume that for the always supporter, even the lowest attribute level would suffice to convince them of the project. For the never supporters, on the other hand, even the highest mark-up proposed in the experiment would have not been enough to compensate them for the introduction of the new milk collection scheme. Given that there is no actual cost incurred by the farmers with respect to the implementation of the project, we assume that the decision behavior of the never supporters is driven by other than economic incentives. For the selective deciders, finally, we can assume that there is a threshold in economic and environmental, or social attributes. Given the small sample size, a further investigation seems not reasonable, however.

Instead, we will explore potential mechanisms of the data generating process. To further investigate this particular response behavior, we employ a multinomial logit regression to explain farmers’ likelihood of belonging to one of the three above described groups.

Multinomial Logit Estimation

The three groups can be assumed as three dichotomous variables, taking the value 1 when a farmer belongs to this group and 0 otherwise. Following (Greene 2008) the model for the probability that a decision maker i with characteristics x_i belongs to one of those groups is:

$$(5.2) \quad Prob(y_i = j) = \frac{e^{\beta_j x_i}}{\sum_{k=1}^J e^{\beta_k x_i}}, \text{ for } j = 1, \dots, J \text{ with } J = 3$$

The probabilities sum to one, therefore only $J - 1$ can be specified. To obtain model identification a convenient normalization was done by setting $\beta_3 = 0$. This means that the remaining coefficients β_j measure the change relative to a reference group, or base category. In this case, we define the largest group, $y = 3$ (always supporter)²⁷ as the reference group. Hence, the coefficients of the multinomial model are interpreted in comparison to this base category. The parameters are not directly interpretable, thus the relative risk ratio has to be computed instead. The exponential value of a coefficient is the relative-risk ratio for a change in the regressor x_i . In this specific case, the regressors relate to the above derived hypotheses on determinants of farmers' approval of cooperative logistics optimization models, i.e., evaluation of the optimization idea, relationship quality, social interaction and attitudes towards climate change.

5.6 Results

Despite the small sample size, we find significant differences between the three groups of never supporters, selective deciders, and always supporters. Nevertheless, the findings have to be treated cautiously, due to the relatively small sample size. Note that due to missing values in the variable for social interaction, five observations were excluded from the analysis. Table 5.5 displays the results of the multinomial logit estimation with the group declared as always supporters representing the base category.

²⁷ The codes for the outcomes 1 to 3 are arbitrary, i.e. no value is placed on a specific category.

Table 5.5 Results of the ML estimation: relative-risk ratios

Variables	Never supporters	Selective deciders
Attitude towards project (H4)	0.0609*** (0.978)	0.373* (0.576)
Attitude towards climate change (H5)	0.163* (1.045)	0.966 (0.460)
Supplier relationship quality (H6)	25.47* (1.764)	0.984 (0.374)
Satisfaction with dairy (H6)	1.176 (0.606)	1.990 (0.510)
Frequent coop member interaction (H7)	13.28* (1.515)	2.932 (0.892)
Constant	0.0141** (1.869)	0.228*** (0.555)

Levels of significance: *** p<0.01, ** p<0.05, * p<0.1

Base category: always supporters

Pseudo R²: 0.33

Observations: 48

Standard errors of log coefficients in parentheses

For the propensity of belonging to the group of never supporters, four variables have a statistically significant impact. First, the relative-risk ratio estimators for *attitude towards project* and *attitude towards climate change* are both statistically significant and below one. This indicates that an increase of either constructs is related to a decline of the relative odds for the group of never supporters compared to the group of always supporters. These findings are consistent with hypotheses 4 and 5. For the group of selective supporters only the *attitude towards the project* is significant in distinguishing the group from always supporters. With a value below one, it indicates, *ceteris paribus*, a decrease in the likelihood of belonging to the group of selective deciders compared to the group of always supporters. The significance of this factor in both groups underlines the importance of the *attitude towards the project* for the approval of cooperation among dairy processors.

Second, *supplier relationship quality* is positively associated with an increase of the relative probability of belonging to the group of never supporters relative to the base category. We thus do not find the hypothesized inverse U-shape relationship, but a negative relationship between SRQ and project support.

Finally, we find *frequent coop member interaction* being associated with an increase in the relative probability of belonging to the group of never supporters. Thus, the relative probability of belonging to the group of never supporters as compared to the group of always support-

ers is *ceteris paribus* higher for farmers characterized by frequent interaction with other members of the same cooperative than for farmers frequently interacting with dairy producers not being members of the cooperative. This is in line with hypothesis H7.

Discussion

The empirical findings revealed in the multinomial logit estimation support by and large our proposed framework of factors influencing farmers' decisions. Despite the necessary change in the empirical strategy due to unbalanced distribution of choice set blocks, we obtain meaningful results for the remaining *hypotheses 4-8*. The multinomial logit regression to explain farmers' specific response behavior to the proposed alternative optimization models in the DCE reveals that especially the never- and always-supporters can be meaningfully distinguished by their levels of social interaction with other members, SRQ with the cooperative, and *attitude towards project*. *Frequent coop member interaction* and SRQ are both associated with an increase in the relative-risk ratios of belonging to the group of never supporters, whereas *attitude towards project* and *attitude towards climate change* are associated with a decrease in the relative-risk ratios of belonging to that group. *Hypotheses 4, 5 and 7* thus are supported by this study, while for *H6*, we do not find a u-shape, but a negative link between member-cooperative relationship and strategy approval. We argue that this latter finding, which may seem contradictory to the literature in relationship marketing, is due to the specific strategy analyzed in this study.

Theoretically, we contribute to the cooperative literature in presenting experimental evidence for the relevance of horizontal and vertical relationships in cooperative member decision-making. Given the specific logistics focus, the results with respect to the negative impact of SRQ may not be generalizable. Studies focusing on other cooperative strategies should therefore take into account the specific implications a measure has for the relationship between a farmer and the other members as well as the cooperative, and formulate their hypotheses respectively. The directions of influence indicate that never supporters are more strongly driven by relational factors in their decision-making than always supporters. The better the relationship with the own cooperative, the less ready a farmer is to accept models which might lead to an erosion of this relationship. The same holds for social interaction with cooperative members.

Furthermore, we add to the literature by examining the spatial embeddedness of social interaction in a cooperative setting. At first glance, the results in the descriptive section did not

directly support hypothesis H8, since the variable measuring the interaction with other cooperative members at the community or neighboring community, level showed no tendency. This may be attributed to the fact that the spatial distribution of peers may have a wider radius than indicated by communities or neighboring communities on average. Nevertheless, the distribution of the share of cooperative social interaction conditional on the extent of cooperative members surrounding the farmer supports this hypothesis.

The practical implications for preparing decisions in a cooperative context are twofold. First, a selective strategy for the communication of new management measures seems reasonable. Social interaction among cooperative members may be associated with spatial dispersion of cooperative members. A selective, regionalized strategy, with a special emphasis on those regions with high member density, can thus be appropriate. Second, the relevance of the attitude towards the project indicates that communication of the advantages and measures of a project is crucial. Communication of environmental effects may be an additional argument for farmers to support the program, as shown by the significance of the respective coefficient (attitude towards climate change) in the group of never supporters.

Conclusion

All in all, the paper proposes a theoretical model and obtains first evidence for factors shaping farmers' approval or disapproval of horizontal cooperation among cooperative processing firms. Awareness of that may ease the implementation of such measures and may give a competitive advantage for small and medium-sized cooperatives. However, despite the response rate of about 20 %, one may criticize the results as being biased due to the small sample size, and we emphasize that the empirical results should be interpreted with caution. A larger sample size and balanced distribution of choice sets would give the opportunity to understand the relevance of the different attributes describing the choices of optimization schemes, i.e., to estimate the marginal effects each attribute has on the likelihood of support. On the other hand, since this research focused on small and medium-sized cooperatives, it may be difficult to obtain much larger samples.

The heterogeneity in farmers' decision-making could be analyzed in more detail with more degrees of freedom. Some omitted variables might challenge our results and should be included in future studies. These include the financial situation of a farmer and the perceived impact of the strategy on the own situation, and an evaluation of the other dairy which is expected to collect the milk. For farmers with low liquidity, it might simply be unaffordable to reject a

proposal which delivers even the slightest mark-up. Questions on the financial situation, however, are difficult to include in surveys. Further, while the personal concern is to some extent covered by the evaluation of the strategy, there could be some other measures to capture the full picture, such as the expectation of being personally affected or not. The evaluation of the other dairy is useful to control for barriers residing in a negative reputation of this company as compared to the current cooperative. Nevertheless, the scenario for the choice experiment is quite realistic, creating unique favorable conditions for the observation of behavior in that context.

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Chapter 6

Conclusion

The purpose of the present dissertation was to investigate farmers' willingness to provide specific food qualities that do not necessarily have an impact on the properties of the final product, but are related to the way they are produced. During the last decade, consumers have become more and more concerned about food production processes, especially in European countries. Organic production, animal welfare and products manufactured in a "natural" way are three broad areas of consumers' interest (Grunert et al. 2004). To some extent, increasing consumers' awareness and demand are the reason why farmers face changing production requirements affecting their farming activities. Production programs introduced by the private sector, as well as the implementation of regulations, are possible ways to enforce those changes. Discrete choice experiments (DCE) can be used to inform private companies or policy makers about farmers' preferences for new technologies, policies or alternative contract designs. Case studies were carried out using this method to reveal farmers' preferences for production programs aiming to enhance process quality. The first study investigates dairy farmers' valuation of support schemes offered by dairy companies to encourage adoption of GM-free milk production. A second study deals with farmers' willingness to participate in a farm animal welfare (FAW) program for dairy cattle. A central question was how the perceived importance of animal wellbeing affects farmers' decision behavior. A third study applied DCEs to both pig farmers and pork consumers using identical choice sets describing hypothetical FAW programs in pig farming. Consumers' willingness to pay for enhanced an-

imal welfare and farmers' requested monetary compensation were combined in order to simulate a market for pork produced in compliance with higher standards. The fourth study deals with a rather different topic. Unlike previous studies, determinants of farmers' willingness to support dairy cooperatives' joint milk collection were investigated. Farmers were asked under what circumstances they would approve of management strategy with the goal to reduce the costs of milk collection and carbon emission introduced by dairy cooperatives. A summary of the main finding of each case study related to existing literature is followed by a critical appraisal of the empirical data and the DCE method. The final section derives implications for policy and industry and makes suggestions for further research.

6.1 Consideration of results in the context of existing literature

Many studies exist on consumers' willingness to pay for process quality attributes like organic production (Van Loo et al. 2011), animal welfare (Lagerkvist et al. 2006; Carlsson et al. 2007; Liljenstolpe 2008) or food that is produced without genetically modified organisms (Burton et al. 2001; Henseleit et al. 2009). In the field of agriculture, this methodology has rather been applied to topics like farmers' acceptance of AES (Ruto and Garrod 2009; Espinosa-Goded et al. 2010; Breustedt et al. 2013), their willingness to adopt or to give up a technology such as cultivation of GM crops (maize or oilseed rape) or the use of hormones in milk production (Birol et al. 2009; Breustedt et al. 2008; Olynk et al. 2012). However, studies to assess farmers' willingness to participate in production programs that target specific process quality aspects are rare in literature. Some comparable work has been provided by Schulz and Tonsor (2010) who investigated how cow calf producers decide about participating in a voluntary traceability system, and by Norwood et al. (2006) analyzed under what circumstances farmers' would accept a voluntary beef checkoff, where they either have to donate a fee that is spent on different business activities (advertising or research) or can request a refund of money.

The first case study in Chapter 2 deals with farmers' willingness to participate in a milk production scheme that requires them to use exclusively feedstuffs deemed GM-free. Results show that farmers who are more reliant on fodder purchased from external sources are less likely to accept such a program. Furthermore, a latent class (LC) model estimation was used to profile farmers who are more or less likely to adopt a GM-free production scheme. Two distinct classes of "adopters" and "non-adopters" were identified- with significant differences in their characteristics. Bavarian farmers are more likely to disapprove of a program as are

farmers with a less critical view on GM-soy cultivation and those who are less convinced of consumers demand. A similar study was conducted by Olynk et al. (2012) who surveyed Michigan dairy farmers to estimate welfare losses when the option to use recombinant bovine somatotropin (rbST) was eliminated from the set of applicable technologies. The authors focus on the economic consequences and neglect potential alternatives of marketing the milk under a hormone-free label. Neither did they account for the fact that farmers might have a negative view on that technology which, according to Bradford et al. (2004), had a significant influence on adoption choices of rbST. Olynk et al. (2012) admittedly employed a random parameter logit (RPL) model to account for heterogeneity in farmers' preferences, but their results refer basically to a "representative" producer. A further study on farmers' willingness to use exclusively GM-free fodder could usefully explore the role of social interaction among peer groups in spatial proximity. As shown by Laple and Kelley (2015) for the case of organic farming, such interdependencies potentially influence farmers' adoption behavior.

The studies in chapter 3 and 4 analyze dairy and pig farmers' willingness to participate in a farm animal welfare (FAW) program. Furthermore, the latter case combines farmers' willingness to accept estimates with consumers' willingness to pay in order to simulate supply and demand curves for high-welfare pork. The specific focus of Chapter 3 was to investigate how values relate to the perceived knowledge that the animal "feels good" and enhanced prestige among relevant peer groups steer dairy farmers' participation. It was found that some farmers always reject such programs as proposed in the choice experiment and at the same time, state high levels of non-use existence values. This result is not in line with Bock and van Huik (2007) who argue that farmers' readiness to implement stricter animal welfare regulations depend strongly on their definition of animal welfare and the importance they attach to it. Farmers who are interested in taking part in specific animal welfare schemes view the provision of higher levels of animal welfare as their moral obligation and regard higher welfare levels as important for the animal itself. In contrast, our analysis has shown that a critical view on FAW program does not necessarily equate with lack of interest in animal welfare. In fact, the potential disutility those farmers derive from such programs is probably caused by perceived loss of autonomy (Key 2005) or lack of familiarity with voluntary programs. Reasons why farmers are opposed to participating in FAW programs should be addressed by future investigations. The study in Chapter 4 explores the acceptance of enhanced levels of farm animal welfare from both sides of the market: pig farmers and pork consumers. Findings suggest that farmers' willingness to participate in a FAW program strongly depends on program

requirements. Compared to other attributes, straw bedding on the entire barn floor requires the highest compensation. In the literature reviewed, no information was found on the necessary compensation farmers wish to obtain for providing higher levels of farm animal welfare. One exception is a staff paper by Wolf et al. (2015) who investigated which animal welfare practices are adopted by dairy farmers in return for a producer price increment. They compared the shares of farmers who are willing to adopt animal-friendly practices before and after offering compensation payments. The largest percentage change occurred for the requirement of having a consistent training program on cow care, third party verification and access to pasture. The authors neglected the potential advantages of a discrete choice study, which are, firstly, to reveal the trade-offs that farmers make between different practices, and secondly, to estimate welfare impacts of certain FAW programs. The study in Chapter 4 further revealed that less intensively managed farms operated by farmers with a long-term planning horizon, and who are selling their products directly to consumers are more likely to adopt animal-friendly practices on their farms. These results corroborate the findings of Bock and van Huik (2007), who concluded that farmers who comply with specific animal welfare schemes operate in a niche market in which its naturalness is perceived to add to quality. Estimations of consumers' willingness to pay for high-welfare pork are for the most part similar to those observed by Lagerkvist et al. (2006) and Liljenstolpe (2008). However, the authors did ascertain whether the demand for high-welfare pork can be met by willing farmers. Based on preference estimates obtained from a consumer and a producer survey, market simulations for different scenarios of farm animal welfare were carried out. From the results, it can be concluded, that stricter standards of FAW lead to diverging supply and demand. A market potential exists for pork with slightly higher standards than the legal minimum, but not for standards that are considerably higher. The study in Chapter 5 uses psychological as well as sociological factors to explain dairy farmers' willingness to support a horizontal cooperative strategy among dairy companies to reorganize milk collection. By means of a multinomial logit (ML) estimation, groups of never-supporters and always-supporters could be distinguished and characterized by their levels of social interactions with other cooperative members, the perceived quality of their relationship with the dairy company and their attitude towards joint milk collection. This paper contributes to the existing literature by providing evidence for the importance of relational factors for cooperative member decision-making. Moreover, using a DCE to measure dairy farmers' approval of an optimization scheme combined with psychological factors is a relatively novel approach.

6.2 Critical appraisal of empirical data

The articles presented in this dissertation are based on five surveys. Data used for analyses in Chapter 2 are collected from 138 dairy farmers in two key milk production regions in Germany. Bavaria represents an area with small-scale farms and reduced availability of grazing area, while Schleswig-Holstein represents a region with favorable natural conditions for dairy farming. The concept of GM-free milk is more popular among the farmers in the southern part of Germany than it is in Schleswig-Holstein. Looking at the descriptive statistics of the samples, differences between the regions in arable land as well as in herd size are obvious and appear plausible²⁸. However, the sample sizes are limited and account for only 2% in Schleswig-Holstein and 0.15% in Bavaria. Conclusions for other regions of Germany cannot therefore be drawn. Another critical point is the fact that all the surveyed farmers in Bavaria are members of the same cooperative. However, the survey yielded a number of 987 choice sets which is sufficient to provide reliable estimates in a choice analysis (Louviere et al. 2000). All in all, our results give hints as to how dairy companies can support and encourage milk producers not to use GM fodder factoring in regional aspects.

The sample size in Chapter 3 was more restrictive than in the other chapters. The model estimation was based on 78 dairy farmers, who were randomly surveyed at trade fair in Hannover in the autumn of 2014. Farmers had to choose between two different animal welfare programs or to continue business as usual. Each questionnaire contained four choice situations, hence 312 choice sets in total. Compared to other discrete choice studies, this sample size is very small. Once a short introduction to the purpose of the study was given, the farmers were surveyed in personal interviews. Face-to-face interviews appear to have practical advantages: when conducting choice experiments, it is possible for the respondent to ask questions regarding the choice task, and it is more likely that questionnaires are filled in completely. Although some farmers viewed the topic “animal welfare” as critical, it was possible to persuade them to participate in the survey. Around 46% of respondents are located in the northern part of Germany, representing one of the most important milk producing regions. Other farm characteristics such as average milk yield and average herd size were higher than the numbers for all dairy farms in Germany, indicating that the sample were above the German average, indicating that the sample rather represents modern, productivity-oriented farms.

²⁸ In Schleswig-Holstein a number of 4418 farms keep on average a number of 88 cows per holding (Statistikamt Nord 2015). In Bavaria a total number of 35148 farms keep on average 35 cows per farm (Verband der Milcherzeuger Bayern e.V. 2014)

A scrutinizing look at the datasets analyzed in Chapter 4 showed that, although a notable sample size of 140 pig farmers and 646 pork consumers was achieved, it must be doubted that the samples are representative of the German population. The average land size of 99 hectares per farm is way above the German average, and so is the capacity of 1462 fattening units²⁹. A low share (4%) of surveyed farms also keeps dairy cows and suckler cows, and 9% also keep fattening beefs and poultry. Only the minority of farmers takes part in agri-tourism and sells products directly to consumers. A considerable share of farmers is selling their fattened pigs to livestock traders or producer associations, whereas only a few of them conclude on contractual agreements or selling pigs directly to butchers. In the choice experiment, a remarkable number of 1120 choice tasks were answered by farmers and 5032 by consumers. Questionnaires were partly administered by sending a link to farmers using online boards and by placing it on the faculty's homepage. Although nowadays only few farmers do not have access to internet, this might lead to a biased sample. Consumers were surveyed using different means. One way was to carry out personal interviews with people who were randomly approached in public. Moreover, an online version of the questionnaire was distributed using flyers, and a market research institute encouraged consumers to take part in the survey. Because the survey was mainly conducted in the northern part of Germany, representativeness cannot be assumed. Moreover, it has to be noted that individuals were asked if they would like to take part in the survey. Probably, only individuals who already have a rather animal-friendly attitude took part in the survey.

The study in Chapter 5 was based upon information obtained from dairy farmers who are members of two different cooperatives. From the distributed questionnaires a limited number of 53 returned completed, accounting for 19 % and 21 % of the respective cooperative's members. In the survey, farmers were asked to choose their preferred milk collection scheme in a sequence of four choice situations. Hence, a relatively small number of 212 choice sets were analyzed. This is too little information to estimate advanced choice models such random parameter logit (RPL) models or latent class (LC) models. Instead, the farmers' response patterns were investigated. More precisely, it was studied why some farmers never approve an optimization model and others supported some, but not all of the models. A better data basis could have allowed for modelling approaches that lead to more valid determinants of farmers' decision behavior. Another critical point that has to be considered is that the object of choice

²⁹ In 2013 only 12% of all pig keeping farms in Germany kept more than 1000 fattening pigs. The average of arable land in 2013 accounted for 59 hectares per farm BMELV (2014).

is a very specific example of a horizontal cooperation. Hence, no transferability of results to other cases is guaranteed. All in all, the datasets used for analyses are not representative of all German farmers, but rather for specific regions. Limited sample sizes and a potential selection bias due to data collection methods cannot be denied. Nevertheless, testing for overall goodness of fit, showed a satisfying accuracy of model specifications. Since the selected production programs under study are representing niche markets rather than mass markets, the small sample sizes are, however, acceptable.

6.3 Critical appraisal of the Discrete Choice method

A discrete choice experiment is an attribute-based stated preference method assessing the value and characteristics of goods by using individuals' stated behavior in a hypothetical setting. Compared to revealed-preference techniques, this approach allows the analyst to elicit utility respondents derive from public goods or new products that have not yet available. Asking respondents to answer a sequence of choice sets, it is possible to apply advanced statistical analyses with only a limited number of respondents. Discrete choice experiments (DCE) can be employed to investigate complex choice situations that are realistic, because respondents face similar alternatives but are asked to choose only one, as is the case like in many purchase situations. In agriculture farmers often have to decide between different technologies, contracts and production schemes. Therefore, DCE are framed in a way that is similar to actual decision-making on farms. In a choice experiment, alternatives are described by their attributes. This setting has important consequences for the modelling of decision behavior. First, it is in line with consumer theory, which postulates that preferences for goods are a function of the attributes possessed rather than the good *per se*. Second, by comparing alternatives, decision makers are forced to consider trade-offs between different attribute levels according to their preferences. The appropriate selection of attributes and corresponding levels is fundamental for the DCE design. Besides statistical properties, also realism and complexity have to be balanced. To some extent there is a risk of non-responses or protest zero responses if the choice task is too complex. Another way to elicit individuals' tastes or preferences is conjoint analysis (CA), where a person ranks or rates several alternatives described by a number of attributes (Backhaus et al. 2008). The main drawback of this technique is that it may place a cognitive burden on respondents, since they are asked to assess several alternatives and to rank them afterwards. Another possibility to get information about preferences, using a CA, is to ask respondents to rate alternatives individually on a scale. Although this approach is the

most popular one, it constitutes very strong assumptions about human cognitive abilities. Rating alternatives does not allow direct comparison between other choices, because there is no theory available to interpret the meaning of a difference between ratings. Instead, it is suggested to transform the rating into a preference ranking, resulting in a “weakly ordered” ranking (Louviere et al. 2000). Compared to other approaches, numerous factors motivate the use of a DCE to infer information on farmers’ and consumers’ preferences. For example, one advantage of DCEs over conjoint analysis (CA) is the consistency with economic theory, namely Random Utility Theory (RUT). This concept was put forward by Thurstone (1927) and was further developed by McFadden (1974). It says that choice behavior is intrinsically probabilistic (compare Chapter 8). Moreover, DCEs are more robust to strategic responses than the open-ended format often used in contingent valuation studies (Adamowicz et al. 1998). In the open-ended format, respondents are asked to state their maximum willingness to pay (WTP) for a change (for example an increase in barn area per pig)³⁰, whereas in the closed-ended format first a sum is specified and then people are asked to choose whether or not they are willing to pay it (Kealy and Turner 1993). Often respondents are tempted to state a WTP or WTA value that does not represent their true preference. There is a variety of reasons for such behavior. For example, individuals attempt to influence the provision of a good or to comply with a presumed expectation. Especially for ethical issues, like farm animal welfare, there is a risk of stating preferences that are socially desired and thus biased (Lusk et al. 2007). However, the implicit valuation of single attributes contributes to the robustness of preference estimates (Louviere et al. 2000). Also, other studies confirm that preferences from hypothetical choice experiments often match with real choices (Carlsson and Martinsson 2008). To mitigate hypothetical bias, there are two distinct ways: the calibration of the survey instruments and statistical calibration. The former includes the use of a “cheap talk” script, directly encouraging subjects to avoid hypothetical bias. The latter approach is to estimate a bias function by comparing responses to a hypothetical survey with a set of calibrated responses that the same subjects would have made if asked to make a real economic commitment (Hess and Daly 2014). Other biases may arise from the price level that is presented in the first choice set (starting point bias) or a relationship of an object of choice to other commodities (relational bias). A starting point bias may occur if respondents have no clue about their true WTP or WTA and assume the initial payment as an approximate value of the goods’ real value

³⁰ Or the amount of money farmers request to accept the change (WTA).

(Tversky and Kahneman 1974). Researchers who investigated a starting point bias do not agree on how to solve this problem (Carlsson and Martinsson 2008; Ladenburg and Olsen 2008). In the context of methodological strengths and weaknesses, it might be beneficial to combine stated preferences with real market data (revealed preferences) in future investigations. Unfortunately, there is no data available on participation rates and price premiums for niche production programs like GM-free milk or FAW programs. In conclusion, DCEs provide an adequate method to predict farmers' willingness to provide specific process qualities demanded by consumers. Furthermore, they are an effective tool for investigating farmers' willingness to support a strategic decision of their buyers. Information about farmers' preferences, in advance to the actual implementation of changes in farm business or management, is useful to enhance acceptance among them. In the next section, implications for policy and business management are drawn from the results of the case studies presented in the present dissertation.

6.4 Implications for policy and business

The objective of this dissertation was to investigate farmers' willingness to provide specific process quality attributes in dairy and pig farming. Furthermore, farmers' willingness to support a horizontal cooperation between dairy companies was an issue addressed in this dissertation. Preference estimates, obtained from DCEs, can inform companies or policy makers how such programs or regulations should be designed in order to achieve better acceptance. The study in Chapter 2 suggests several courses of action for dairy companies wishing to supply GM-free dairy products. First, not all farmers are in favor of the scheme, but still a notable share of farmers in the north of Germany is actually willing to abandon GM-fodder. Second, on average farmers require a mark-up of 0.80 eurocent per kilogram milk. Besides the price premium, feed monitoring and to some extent technical advice, are positively valued by farmers and should be offered by dairy companies. The role of soft factors, like farmer's attitude toward GM-crop cultivation and expectations on consumers' demand, turned out to be of significant importance for the likelihood of adoption. An effective marketing strategy could be used as a tool to convince farmers to collaborate. Useful information for dairy companies wishing to set higher standards in animal welfare can be derived from the study in Chapter 3. Previously to the data analysis it was hypothesized that farmers who care for their animals are more likely to participate in a farm animal welfare (FAW) program. We expected that individual benefits derived from adopting a program would be greater if the level of perceived

non-use existence values are higher compared to farmers with lower levels. Instead, we found that farmers who are generally opposed to FAW programs state consistently high levels of non-use existence values. Those farmers rejected all the programs regardless of their requirements and compensational payments. Thus, it appears that such programs provide a relevant amount of disutility that might arise from loss of autonomy or lack of familiarity with voluntary quality programs. Although concrete implications cannot be drawn from our findings, they indicate that farmers who are generally critical toward FAW programs are not necessarily less animal-friendly than farmers who are willing to participate. Dairy processors should therefore seek the dialogue with milk producers and communicate how such programs can contribute to farmers' business benefit. The findings of the study in Chapter 4 have some practical implications for the future design of animal welfare programs in pig fattening. Despite the fact, that pig farmers are generally willing to participate in a FAW program, they require an increment on the price per kilogram carcass weight that exceeds arising implementation costs. In particular, the provision of straw bedding that covers the entire barn floor is strongly disliked. Farmers who sell their products directly to consumers and run less intensive farms are more likely to adopt animal-friendly practices in order to present a good image of pig farming. Results from the analyses of consumer data showed that consumers are generally willing to pay more for better conditions in pig farming. Especially women and persons who frequently consume organic products have a higher preference for welfare pork. However, the findings have to be assessed carefully, because they might be biased by social desirability effects. Market simulations for high-welfare pork showed that with higher standards supply and demand curves diverge increasingly. Hence, a welfare program that imposes considerably high requirements did not result in a market balance. Probably, consumers perceive very high-welfare standards equal to organic livestock practices and would rather buy organic pork at a similar price. Moreover, farmers who prefer a conventional farm system might not be willing to implement standards that are almost as high as organic standards and thus require a compensational payment that is above the average. It is difficult to derive implications from the last case study in Chapter 5, because the choice task was related to a very specific issue: cooperation between dairy processors related to the milk acquisition. Moreover, the estimation was based upon a very small sample. In this case, recommendations can only be made for the dairy companies involved in this project. However, our findings, while preliminary, suggest that the cooperatives should carefully communicate new management measures to farmers taking into account that interaction between members might influence their view on the pro-

posed strategy. Therefore it is recommended, that regionalized communication strategies should be developed with a focus on communicating the environmental benefits of an optimized milk collection.

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Chapter 7

Zusammenfassung

Die vorliegende Dissertation beschäftigt sich mit der Bewertung prozessbezogener Qualitätskonzepte bei der Produktion tierischer Lebensmittel unter Anwendung von Discrete Choice Experimenten (DCE). Die Gesellschaft interessiert sich zunehmend dafür, in welcher Art und Weise Lebensmittel hergestellt werden und verlangt nach Produkten, die unter bestimmten Bedingungen produziert wurden. Um diesen Bedürfnissen nachzukommen, reagieren sowohl Privatwirtschaft als auch Agrarpolitik mit der Einführung neuer Standards und Produktionsprogrammen, die wiederum neue Anforderungen an die Landwirtschaft stellen (z. B. in Form von veränderten Haltungsverfahren, Verzicht auf gentechnisch veränderte Futtermittel). Für deren erfolgreiche Umsetzung ist die Akzeptanz der Primärproduzenten maßgeblich. Im Rahmen dieser Dissertation wurden Fallstudien durchgeführt, anhand derer die Bereitschaft zur Übernahme von Programmen, sowohl zur Produktion von Gentechnik-freier Milch, als auch zur Verbesserung des Tierwohls in der Milchvieh- und Schweinehaltung, untersucht. Überwiegend wurden die DCE mit Landwirten durchgeführt, um die Akzeptanz für genannte Programme zu evaluieren. Ergänzend wurde in einer Studie (siehe Kapitel 4) aus einem DCE ermittelte Zahlungsbereitschaften von Konsumenten hinzugenommen, um eine Marktsimulation für Schweinefleisch, das unter erhöhten Tierwohl-Standards produziert wird, durchzuführen. Zusätzlich zu der Akzeptanz von Produktionsprogrammen, wurde auch die Bereitschaft von Milchviehhaltern untersucht, eine Kooperation zwischen Molkereien in Form der gemeinsamen Milchsammlung mitzutragen, um die Produktion kosteneffizienter und umweltfreundlicher zu gestalten. Die Ergebnisse der einzelnen Studien zeigen, dass nicht nur ökonomische Kennzahlen in die Bewertung von Produktions-Programmen bzw. Kooperationen

durch die Landwirte einfließen, sondern auch „soft factors“, wie beispielsweise die generelle Einstellungen zu Tierwohl und Gentechnik oder auch die Einschätzung der Geschäftsbeziehungsqualität zwischen Molkerei und Landwirt eine Rolle im Entscheidungsprozess spielen. Des Weiteren ist die Entscheidung für oder gegen ein Produktionsprogramm oder eine strategische Maßnahme seitens der Molkerei nicht nur von den resultierenden Änderungen im betriebswirtschaftlichen Ablauf abhängig, sondern auch von der Struktur des jeweiligen Betriebes, sowie den sozio-ökonomischen Eigenschaften der Landwirte. Im Folgenden werden die Fallstudien zusammenfassend beschrieben und relevante Ergebnisse wiedergegeben.

Die Bewertung von Anreizen zur Produktion von Gentechnik-freier Milch: Erkenntnisse eines Discrete Choice Experimentes in Deutschland

Dieser Artikel basiert auf einem DCE mit 151 Milchviehhaltern aus zwei unterschiedlichen Regionen Deutschlands, genauer aus Schleswig-Holstein und Bayern. Dabei wurde untersucht, unter welchen Bedingungen Landwirte bereit sind auf Gentechnisch-veränderte Futtermittel in der Milchproduktion zu verzichten. Eine Besonderheit gegenüber anderen DCE-Studien ist, dass nicht nur kostenwirksame Auflagen, wie die Dokumentation der Futtermittelbeschaffung durch Lieferscheine oder zusätzliche Futtermittelkontrollen einbezogen wurde, sondern auch unterstützende Maßnahmen, die den Landwirten die Umstellung auf Gentechnik-freie Produktion erleichtern sollen. Dazu wurde seitens der Molkerei beispielsweise angeboten, die Beschaffung entsprechender Futtermittel zu übernehmen, eine Liste mit Lieferanten aus der Region bereitzustellen, eine kostenlose einmalige oder regelmäßige Futtermittelberatung durch einen Mitarbeiter der Molkerei oder eine dritte Institution (zum Beispiel Beratungsringe) durchzuführen. Hinzu kommt das Angebot, Futtermittel zusätzlich auf den Eintrag von gentechnisch veränderten Bestandteilen zu kontrollieren. Durch die Schätzung eines konditionalen Logit-Modells wurde getestet, inwieweit die einzelnen unterstützenden Maßnahmen der Molkerei einen motivierenden Einfluss auf die Akzeptanz des Programms haben und in welcher Höhe ein Aufschlag auf den Milchpreis zu zahlen ist, um die Teilnahme der Landwirte zu erwirken. Die Schätzergebnisse zeigen, dass neben dem monetären Anreiz, das Futtermittel-Monitoring durch die Molkerei die Übernahmewahrscheinlichkeit erhöht. Da die Landwirte einen Aufschlag nur erhalten, wenn die verwendeten Futtermittel nachweislich Gentechnik-frei³¹ sind, ist diese zusätzliche Absicherung als Instrument des Risikomanage-

³¹ Nach EU Verordnung 1829/2003/EG sind Lebens- und Futtermittel, die weniger als 0,9% gentechnisch veränderte Bestandteile enthalten von der Kennzeichnungspflicht ausgenommen.

ments zu verstehen. Weiter zeigen die Ergebnisse, dass die Bereitschaft zur Produktion Gentechnik-freier Milch sinkt, sollte die Molkerei die Beschaffung der Futtermittel übernehmen wollen. Einen vergleichbaren Effekt hat eine vertraglich vereinbarte Umstellungsberatung. Diese Reaktion ist vermutlich auf die Einschränkung unternehmerischer Freiheit zurückzuführen. Die angebotene Beratung wird jedoch teilweise von denjenigen Landwirten positiv bewertet, die zuvor bereits Beratung in anderen Bereichen in Anspruch genommen haben. Im Entscheidungsprozess spielen auch die Eigenschaften des Landwirtes und seines Betriebes eine relevante Rolle. Beispielsweise die allgemeine Einstellung zur grünen Gentechnik, die Erwartung der zukünftigen Verbrauchernachfrage nach Gentechnik-freier Milch, die prospektive Einschätzung von Soja- und Ölsaatenpreisen, das Bildungsniveau der Landwirte und das derzeitige Fütterungsregime weisen einen signifikanten Einfluss auf die Übernahme eines Programmes auf. Ein Vergleich der Stichproben nach Region ergab eindeutige Unterschiede in den Präferenzen. Während Landwirte aus Schleswig-Holstein im Schnitt eine grundsätzlich höhere Bereitschaft zeigen auf Gentechnik-Futtermittel zu verzichten, reagieren Milchviehhalter aus Bayern *ceteris paribus* stärker auf eine Erhöhung des angebotenen Kompensationspreises. Ein weiterer Analyseschritt, um die Einflüsse der unterschiedlichen Eigenschaften und Betriebsstrukturen zu erfassen bestand in der Schätzung eines Latent Class Modells, durch das zwei Gruppen, „Annehmer“ und „Ablehner“, identifiziert werden konnten. Über die Hälfte der befragten Landwirte konnten der Gruppe der „Annehmer“ zugeordnet werden. Zwar verlangen Landwirte aus dieser Gruppe *ceteris paribus* einen höheren Kompensationspreis, doch führt das Angebot der kostenlosen Beratung und eines Futtermittel-Monitorings durch die Molkerei zu einer möglichen Senkung der notwendigen Ausgleichszahlung.

Die Rolle nutzungsunabhängiger Werte für die Akzeptanz von Tierwohl-Programmen in der Milchviehhaltung

Die Bedeutung nutzungsunabhängiger Werte (NUV) für die Teilnahme von Milchviehhaltern an einem Tierwohlprogramm wurde in Kapitel 3 eingehend untersucht. Nutzungsunabhängige Werte sind in diesem Zusammenhang als Werte zu verstehen, die allein aufgrund des Wissens um die Existenz des Wohlergehens der Tiere bestehen können (non-use existence value). Weiter wird untersucht, ob und inwieweit die Meinung von Individuen außerhalb des landwirtschaftlichen Betriebes (paternalistic altruism-related NUV) die Übernahme von Tierwohl-Programmen beeinflusst. Hypothetische Tierwohlprogramme, variierend in ihren Anforderungen, von erforderlichem Weidegang bis hin zu Zellzahl-Grenzwerten der Milch, wurden

Milchviehhaltern zur Wahl gestellt. Es wurde angenommen, dass die Umsetzbarkeit der geforderten Maßnahmen, die Auswirkungen dieser auf die Wirtschaftlichkeit des Betriebes z.B. auf Milchleistung, Milchqualität, sowie Produktionskosten und Arbeitsaufwand, und nutzungsunabhängige Werte die Akzeptanz bestimmen. Als weiterer Einflussfaktor wurde soziale Interaktion, abgeleitet von der Haushaltsproduktionstheorie nach Becker (1974), in die dem Verhalten des Landwirts zugrunde liegende Nutzenfunktion aufgenommen. Die Theorie postuliert, dass ein Haushalt seinen Nutzen maximiert, indem er Güter konsumiert, die er teilweise selbst im Rahmen seiner Produktionsmöglichkeiten (verfügbare Inputs und Zeitallokation) herstellt (z. B. Milch). Die notwendige Zeit, die für den Produktionsprozess aufgewendet werden muss, wird dabei zu den Haushalts-spezifischen Opportunitätskosten (z.B. Verdienst außerhalb der Landwirtschaft) bewertet. Die Entscheidung über den Einsatz von Inputs und Zeit und damit über die Menge der produzierten Milch hängt annahmegemäß von den Eigenschaften des Landwirtes ab. Weiterhin wird angenommen, dass auch Eigenschaften derjenigen Personen, die sich außerhalb des Haushaltes befinden vom Entscheidungsträger wahrgenommen und bewertet werden. Dies bedeutet, dass die gesellschaftliche Meinung über Tierwohl oder auch die Meinungen und der Kenntnisstand anderer Landwirte (Peergroup) in diesem Bereich einen Einfluss auf das Verhalten des Landwirtes haben. Wie erwartet haben alle Koeffizienten der Programmanforderungen ein negatives Vorzeichen, da die Umsetzung der Auflagen *ceteris paribus* zusätzlichen Aufwand bedeutet. Je restriktiver die geforderten Maßnahmen ausfallen, desto höher ist der vom Landwirt geforderte Kompensationspreis, z.B. wird für die Einhaltung eines Zellzahl-Grenzwertes von $150.000 \cdot 10^3$ mg Zellen eine Kompensation von 2,8 Eurocent pro Kilogramm Milch verlangt und für eine Zellzahlgrenze von $125.000 \cdot 10^3$ mg Zellen eine entsprechend höhere Zahlung von 4,8 Eurocent pro Kilogramm. Die Ergebnisse zeigen weiter, dass die nutzungsunabhängigen Werte negativ mit der Akzeptanz eines Tierwohlprogrammes korrelieren. Wichtige Treiber für die Übernahme eines Programms sind dagegen, erwartete positive Effekte erhöhten Tierwohls auf die Leistungsparameter der Kuh, sowie reduzierter Aufwand (Produktionskosten, Arbeitsaufwand etc.). Sowohl die Größe der Peergroup, als auch die Intensität des Austausches über Themen in Bezug auf Tierwohl erhöhen die Wahrscheinlichkeit der Annahme eines Programmes. Das weist darauf hin, dass soziale Interaktion Diffusionsprozesse von Tierwohlprogrammen fördern kann. Der Einfluss der nutzungsunabhängigen Werte auf die Übernahme eines Tierwohlprogrammes ist auf den ersten Blick nicht eindeutig zu interpretieren. Landwirte, die einem Tierwohlprogramm ablehnend gegenüberstehen, bekunden interessanterweise durchweg hohe nutzungsunabhängige

Werte. Erwartungsgemäß sollte die Wertschätzung von Maßnahmen, die das Tierwohl erhöhen zunehmen, wenn Landwirte angeben auch einen persönlichen Nutzen aus dem Wohlergehen der Tiere zu ziehen. Eine Analyse des Entscheidungsmusters ergibt eine Aufteilung der Probanden in drei Gruppen: Landwirte, die immer eines der vorgeschlagenen Tierwohlprogramme gewählt haben, welche die in einigen Situationen eines der Programme akzeptierten, in einigen anderen Situationen wiederum nicht; und Milchviehhalter, die nie ein Tierwohlprogramm angenommen haben. Innerhalb der Gruppe derjenigen Landwirte, die nie eines der Programme angenommen haben, werden die nutzungsunabhängigen Werte vergleichsweise stark gewichtet. Offenbar gibt es eine Gruppe von Landwirten, die einen hohen Nutzen aus dem Wohlergehen ihrer Tiere ziehen, aber gleichzeitig einen negativen Nutzen aus der Teilnahme an einem Tierwohlprogramm. Innerhalb der Gruppe derer, die immer ein Programm akzeptierten, variieren die nutzungsunabhängigen Werte sehr stark. Es ist möglich, dass bestimmte Landwirte eher eine positive Außenwirkung bzw. eine Imageverbesserung durch die Teilnahme anstreben, als tatsächlich das Wohlergehen der Milchkühe zu verbessern. Dass die Teilnahme an Tierwohlprogrammen kein eindeutiger Indikator dafür ist, in wie fern Landwirte bereit sind das Tierwohl auf ihrem Betrieb zu erhöhen, ist eine wichtige Botschaft, die aus diesen Ergebnissen abgeleitet werden kann.

Eine Prognose des Angebotes und der Nachfrage nach Tierwohl-Schweinefleisch in Deutschland.

Diese Studie verbindet die Bereitschaft von Schweinemästern, Tierwohl-Programme anzunehmen mit der Zahlungsbereitschaft für Schweinefleisch, das eben unter diesen Bedingungen produziert wurde. Hypothetische Tierwohlprogramme, die sich lediglich in der Preisvariablen unterscheiden, wurden sowohl 140 Landwirten als auch 629 Konsumenten zur Auswahl in einem DCE vorgelegt. Anhand der dadurch ermittelten notwendigen marginalen Kompensationszahlungen und Zahlungsbereitschaften wurden eine Angebots- und Nachfragefunktion für spezifische Tierwohl-Szenarien simuliert. Eine Analyse der Discrete Choice Daten ergab einerseits, dass Landwirte mit längerfristigem Planungshorizont als der Durchschnitt und diejenigen, die Schweinefleisch direkt an die Verbraucher vermarkten eher bereit sind ein Tierwohl-Programm zu akzeptieren. Die Anzahl an Mastplätzen und die Abneigung einem Tierwohl-Label gegenüber verringert dagegen die Wahrscheinlichkeit der Teilnahme signifikant. Eine Gegenüberstellung der tatsächlichen Kosten, die aus der Umsetzung der Auflagen entstehen, und den geforderten Erlösen der Landwirte zeigt auf, dass Landwirte durchschnittlich

höhere Kompensationen verlangen, als zur Deckung der Kosten notwendig sind. Aus der Schätzung des Konsumentenmodells konnte ermittelt werden, dass die Konsumhäufigkeit von Schweinefleisch, die Abneigung Bio-Lebensmittel zu kaufen, und die Präferenz Fleisch sowohl preisgünstig, als auch an der Selbstbedienungstheke im Supermarkt zu beziehen, die Zahlungsbereitschaft der Verbraucher verringert. Positiv auf die Wahlwahrscheinlichkeit nach Tierwohlfleisch wirken sich dagegen eine kritische Grundeinstellung den Haltungsbedingungen landwirtschaftlicher Nutztiere gegenüber, der regelmäßige Konsum von Bio-Lebensmitteln, das weibliche Geschlecht, ein Anstieg der Konsumausgaben für Lebensmittel, sowie das Wohnen in einer Großstadt aus. Aus den berechneten individuellen Kompensationspreisen und Zahlungsbereitschaften wurden mögliche Schlachtpreise für Tierwohl-Schweinefleisch kalkuliert und auf den gesamtdeutschen Markt hochgerechnet. Ermittelte Marktanteile für unterschiedliche Standards, die von einer Einstiegsstufe bis hin zu erhöhten Standards reichen, ergaben ein differenziertes Bild. Fleisch, das nur zu geringfügig höheren Anforderungen (Platzanspruch pro Tier: 1,33 m²) als dem Mindeststandard produziert wird deckt einen Marktanteil von 38% zu einem Gleichgewichtspreis, der nur 10 Eurocent über dem Referenzpreis (1,70 €/KG) liegt. Bei einem Programm, das hohe Platzanforderungen stellt und Einstreu im gesamten Stall erfordert, konnte kein Marktgleichgewicht ermittelt werden, da der geforderte Erlös der Produzenten stetig über dem möglichen Schlachterlös aus den Zahlungsbereitschaften der Konsumenten lag. Die Analysen dieser Studie zeigen, dass nur wenige Landwirte zur Teilnahme an einem Tierwohl-Programm bereit sind. Die geforderten Schlachterlöse liegen in der Durchschnittsbetrachtung bei allen Programmen über dem möglichen Schlachtpreis aus der Zahlungsbereitschaft der Verbraucher. Der Großteil der Konsumenten war bereit eine Preisprämie für Schweinefleisch aus tierfreundlicher Produktion zu zahlen. Im Hinblick auf die Marktsimulationen wird deutlich, dass mit ansteigenden Anforderungen, die Präferenzen zunehmend auseinander gehen. Folglich bestimmt die Ausgestaltung dieser Programme deren Markterfolg und sollte bei der Entwicklung von Programmen berücksichtigt werden.

Unterstützen Landwirte horizontale Kooperationen zwischen Molkereien? Empirischer Test eines konzeptuellen Modells

Durch horizontale Kooperationen können klein- und mittelständische Molkereien Kapazitäten besser nutzen, um kosteneffektiver produzieren. Strategische Entscheidungen dieser Art sind innerhalb kooperativer Strukturen nur realisierbar, wenn die Organisationsmitglieder diese auch mittragen. Diese Studie untersucht daher Determinanten der Ablehnung oder Befürwortung einer strategischen Entscheidung am Beispiel der Zusammenlegung der Milchsammlung und Routenoptimierung. Dabei werden dem Modell nicht nur ökonomische Prinzipien zugrunde gelegt, die das Verhalten der Akteure erklären, sondern auch psychologische und soziale Faktoren untersucht. Um die Akzeptanz von Landwirten der gemeinsamen Milchsammlung zweier Molkereien gegenüber zu messen, wurden DCE durchgeführt, die alternative Modelle vorstellen. Dabei kann einerseits die Milchabholung, wie bisher, durch die eigene Molkerei erfolgen, aber auch andererseits durch eine konkurrierende Molkerei, wenn sich der Betrieb im Einzugsgebiet befindet. Eine weitere Möglichkeit ist die Abholung der Milch durch ein Speditionsunternehmen. Darüber hinaus variieren die vorgeschlagenen Alternativen in einer möglichen Reduktion der CO₂-Emission, sowie einer Kosteneinsparung, die über den Auszahlungspreis an die Milcherzeuger zurückgegeben wird. Weiterhin werden Einstellungen der Landwirte zur Umwelt, Supply-Chain-Orientierung und die Einschätzung der Geschäftsbeziehungsqualität anhand bereits bestehender Skalen abgefragt. Das abgeleitete Modell wird anhand empirischer Daten von 53 Milcherzeugern zweier norddeutscher Molkereien geprüft. Das Antwortmuster wird mittels eines multinomialen Logit Modells untersucht und differenziert zwischen Landwirten, die immer ein kooperatives Modell gewählt haben, denjenigen, die nur in einigen Situationen eine Kooperation wählten, und denjenigen, die nie ein kooperatives Modell akzeptieren. Signifikante Unterschiede zwischen den Landwirten aus den unterschiedlichen Gruppen bestehen vor allem im Hinblick auf sozialer Interaktion mit anderen Mitgliedern der Molkerei, der Einschätzung der Geschäftsbeziehungsqualität und die generelle Einstellung der Zusammenlegung der Milchsammlung gegenüber. Die Wahrscheinlichkeit in der Gruppe der Ablehner zu sein steigt mit zunehmender Frequenz der Interaktion mit anderen Mitgliedern und einer hohen Bewertung der Geschäftsbeziehungsqualität zwischen Landwirt und Molkerei. Eine positive Bewertung des Projekts der gemeinsamen Milchabholung und eine kritische Einstellung bezüglich des Klimawandels verringern den Wahrscheinlichkeits-Quotienten der Landwirte dieser Gruppe anzugehören. Bei der Untersuchung der Akzeptanz von Kooperationen als Resultat strategischer Entscheidungen sind nicht nur die

Ansichten des Landwirts bezüglich des Projektes von relevanter Bedeutung, sondern auch, den Ergebnissen nach zu urteilen, die generelle Beziehung zum Management der Molkerei und zu anderen Mitgliedern der eigenen Kooperative. Die Bedeutung der sozialen Interaktion zwischen den Mitgliedern sollte durch das Management der Molkerei bei der Kommunikation strategischer Maßnahmen genutzt werden, um eine positive Übereinkunft mit den Mitgliedern zu erreichen. Um die Lieferantenbindung zu stärken empfehlen Spiller und Wocken (2006)³² beispielsweise ein aktives Beschwerdemanagement mit einem klar definierte Ansprechpartner, sowie einer Schulung aller lieferantennahen Mitarbeiter. Solche Kommunikationskonzepte könnten regionalen Gegebenheiten angepasst werden, um die Vorteile der optimierten Milchsammlung für jeden betroffenen Lieferbezirk herauszustellen.

³² Spiller, A. und C. Wocken (200) Supplier Relationship Management: Konzepte zur Verbesserung der Geschäftsbeziehung zwischen Milcherzeugern und Molkereien. In *Deutsche Milchwirtschaft* 3(57): 108-110.

Chapter 8

Methodological Appendix

8.1 Introduction

Only a few remarks on the methodological focus were given in the previous case studies. To give a deeper insight into the theory behind discrete choice experiments (DCE), this chapter presents the theoretical underpinnings as well as details on the econometric models that are employed to analyze choice data. Since the case studies focus on analyzing heterogeneous preferences among respondents, special attention is given to model specifications that are able to capture varying preferences.

First, fundamental principles and theoretical foundation of the method will be presented, followed by an explanation of how to conduct a DCE including the necessary steps from the efficient design of choice sets to techniques of data collection. Subsequently, the different model specifications will be elucidated using examples of case studies presented in previous chapters. Measures of model fit will be explained in addition to underpin the selection of a certain model specification.

In the case study *Farmers' valuation of incentives to produce GM-free milk: insights from a Discrete Choice Experiment in Germany* (compare chapter 2) a latent class model was applied to account for varying preferences between different groups of farmers. Results confirmed the model fit as two groups of adopters and non-adopters of a GM-free production scheme could be significantly identified. Moreover, interaction terms between the attributes of the production scheme and farm characteristics accounted for heterogeneity and resulted in significant differences in farmers' openness for technical support. In the case studies in chapter 3 (*The role of non-use values in dairy farmers' willingness to accept a farm animal welfare pro-*

gram) and chapter 4 (*Predicting supply and demand for high-welfare meat with Discrete Choice Experiments: an application to the German pork market*) a random parameter logit (RPL) model was employed to capture varying preference among farmers and consumers. The RPL model allows for heterogeneity across respondents and results therefore in more accurate willingness to pay (WTP) and willingness to accept (WTA) estimates than the standard logit model. By means of a multinomial logit model (also referred to as conditional logit (CL) model) a further investigation of response patterns was conducted in chapter 5 (*Dairy farmers' support of horizontal cooperation among dairy processors: conceptual model and empirical testing*). Farmers were allocated into groups according to their response behavior to optimization models regarding a joint milk collection proposed by dairy processors. Meaningful differences between the group of farmers who have never supported the cooperative strategy and farmers who have always chosen an optimization model were found.

8.2 Theoretical framework for Discrete Choice Experiments

Discrete choice experiments (DCE) are employed to examine decision makers' choices among alternatives, so called choice sets, under the assumption of utility maximizing behavior. The decision makers can be people, households or firms, and the alternatives might represent competing products, courses of action, or any other options or items over which choices must be made (Train 2003). Although the theoretical foundation of DCE originates from consumer theory, this method is applied to a broad range of scientific fields, for example on issues related to policy design in agriculture, natural resources, food and energy (Birol et al. 2008), in environmental valuation (Hoyos 2010) or health economics (Bekker-Grob et al. 2012).

The theory behind DCE is mainly based on consumer theory developed by Lancaster (1966) and the Random Utility Theory (RUT), a concept originated from psychology (Thurstone 1927) and further developed by Marschak (1960) who transferred the concept to economics and provided the derivation for utility maximization. Another extension of the concept was provided by McFadden (1974). The core idea of Lancaster's characteristics theory of value is that utility is derived from the attributes or characteristics of the good, rather than from the good itself. This approach breaks away from the assumptions of traditional consumer theory implying that goods are the direct objects of utility. Furthermore the theory says, that consumption is an activity in which goods, singly or in combination are inputs and in which the output is a collection of characteristics. Changes in attributes might cause changes in utility

and hence result in a discrete switch from one bundle of goods to another that will provide the most beneficial combination of attributes. Lancaster's approach enriched the conventional model of consumer behavior in heuristic explanatory and predictive power. In contrast to conventional consumer theory assuming a continuous space of alternatives, discrete choice theory applies a discrete representation. This implies that the consumption of a good can be zero such that the maximization problem may have a corner solution, a point where the first order condition for an optimum do not hold. Because of this property it is impossible to use maximization techniques of calculus to derive demand functions and therefore utility functions are applied instead (Ben-Akiva and Lerman 2000). Based on the discrete character of alternatives, Train (2003) indicated three prerequisite characteristics of a choice set. First, the alternatives must be mutually exclusive from the decision makers' perspective, i.e. choosing one alternative means not choosing any of the other alternatives. Second, the choice set must be exhaustive in that all possible alternatives are included. The decision maker necessarily chooses one of the alternatives. Third, the number of alternatives must be finite i.e. countable. The first two conditions are not restrictive and can usually be satisfied. On the contrary, the third condition is actually restrictive and represents the defining characteristic of discrete choice models, distinguishing the realm of application from that for regression models with an infinite number of possible outcomes for the dependent variable (Train 2003).

In the context of Lancaster's theory, decision behavior is deterministic and therefore models would not hold if decision behavior is assumed to be stochastic. Neglecting latent constructs, for instance individuals' attitudes and beliefs, as well as influences of attributes that are not observed may result in biased interpretation of choice behavior. Those inconsistencies are addressed by the Random Utility Theory (RUT). A framework that provides a more appropriate approach for analysis of choice behavior by taking uncertainty into account that arises from researchers' lack of knowledge about the individuals' decision process. The theory postulates that choice behavior is intrinsically probabilistic and as such random. Decision makers may have perfect information about their preferences in mind, whereas analysts cannot observe all factor influencing individuals' utility. To capture uncertainty utility is seen as a latent construct being composed of two components, a systematic (explainable) part and a random (unexplainable) part. The inclusion of a random term captures deviations in repeated choice situations, effects of unobserved taste variations among individuals, unobserved attributes of alternatives and measurement errors (Ben-Akiva and Lerman 2000). Decision makers are as-

sumed to always choose the utility-maximizing alternative. This implies that the actual choice of an individual is the manifestation of its underlying utilities.

The utility U the decision maker n obtains from choosing the j^{th} alternative can be thus written as:

$$(8.1) \quad U_{nj} = V_{nj} + \varepsilon_{nj}$$

According to Lancaster (1966) the deterministic part V_{nj} is modelled as an additive function of observable attributes of the alternatives x_{nj} and characteristics of the decision maker z_n ; ε_{nj} is unknown and treated as random capturing all idiosyncrasies indicated above. Following Lancaster (1966), the representative part of the utility function is modelled as the sum of influences of I attributes of the j^{th} alternative and M characteristics of the n^{th} individual:

$$(8.2) \quad V_{nj} = \alpha_0 + \sum_{i=1}^I \alpha_i x_{nji} + \sum_{m=1}^M \beta_{jm} z_{nm}$$

The constant α_0 is specific to the alternative and captures the average effect on utility of all factors that are not included in the model. Estimated parameters α and β provide information about the impact of alternative attributes and individuals characteristic on the choice probability. This expansion of the representative utility V_{nj} shows that the relative importance of alternative attributes is homogeneous across the population under study since the utility parameters α_i are not subscripted n (Louviere et al. 2000). Assuming utility-maximizing behavior, the decision maker will choose the alternative j^* providing the highest utility over all other alternatives. Thus the equation above can be written as:

$$(8.3) \quad \max_j U_{nj} \Leftrightarrow V_{nj^*} + \varepsilon_{nj^*} \geq V_{nj} + \varepsilon_{nj} \text{ for all } j \in J$$

Therefore the probability that the decision maker n chooses the most preferred alternative j^* from a finite set of discrete alternatives J is:

$$(8.4) \quad P(j^* | J) = \Pr(U_{nj^*} > U_{nj}) \forall j \in J; j^* \neq j$$

$$(8.5) \quad = \Pr(V_{nj^*} + \varepsilon_{nj^*} > V_{nj} + \varepsilon_{nj}) \forall j \in J; j^* \neq j$$

$$(8.6) \quad = \Pr(\varepsilon_{nj} - \varepsilon_{nj^*} > V_{nj^*} - V_{nj}) \forall j \in J; j^* \neq j$$

Taking into account an unobservable random part ε_{nj} (see equation 8.1 ff.), the researcher can only analyze decision behavior up to a probability of event selection (Louviere et al. 2000).

Consequently, the researcher has to establish a way to handle information associated with the random term, that is, distributional assumptions on ε have to be made (Hensher et al. 2005). With a proper model specification utility weights can be obtained from the estimated function and the probability of choice for a specific alternative depending on attributes and the characteristics of the decision maker can be predicted as outcome. Furthermore the willingness to pay (WTP) and willingness to accept (WTA) can be calculated as described in Section 8.4.

8.3 Conducting a Discrete Choice Experiment

A discrete choice experiment (DCE) is a widely used, attribute-based stated preference method assessing individuals' preferences for characteristics of goods or services. In most applications each respondent faces several choices in one survey. The choice sets consist of alternatives that are described by a number of characteristics, so called attributes, for which in turn varying levels have to be defined. Normally, choice sets are presented to the respondents in a sequence that can be chosen randomly, usually applied in online surveys, or the choice sets are previously divided into blocks as it is mostly the case in paper-based surveys.

After formulating the decision problem and deciding on the target population, the next step in conducting a choice experiment is the decision about the type and number of alternatives that are presented to each individual in a choice set. It is possible to use a generic form; i.e. alternatives are simply marked with numbers or letters (for example A, B, C) or to label the alternatives with an alternative-specific description. It is recommended to use a generic labelling if individuals' focus should be more on attributes of alternatives than on the alternative in general. In contrast, labelled alternatives are often valued in context with the label. As a result, trade-offs are not only made between single attributes, because the label itself conveys information and may be used to infer missing information about the alternatives (Louviere et al. 2000). The number of alternatives within a choice set depends on the research question. Auspurg and Liebe (2011) propose not to include more than four alternatives to avoid cognitive burden and in turn biased choices resulting in unreliable estimates. Another important issue to optimize the amount and quality of information obtained from the choice experiment is whether to include a base case scenario (status quo) or an opt-out alternative. This decision has to be made when the current situation and/or non-participation is a relevant alternative and more in accordance with the respondents' choice option in real life (Amaya-Amaya et al. 2008). For example in the study *The Role of NUV for farmers' acceptance of dairy cattle wel-*

fare scheme (chapter 3), respondents face two possible animal welfare schemes and a status quo alternative stating “no participation”. Some farmers might have preferences not to take part in a scheme, regardless of the required measures or the price premium payed to them. Due to the voluntariness of participation it seemed to be appropriate to include the status quo option to ensure the choice to be more realistic.

The next step of identifying relevant attributes and attribute levels that affect respondents' choices is of particular importance. According to Amaya-Amaya et al. (2008) “[...] *A good experiment is one that has a sufficiently rich set of attributes and choice contexts, together with enough variation in the attribute levels necessary to produce meaningful behavioral responses in the context of the strategies under study.*”. Nevertheless it has to be considered that the number of possible choice sets increases with the number of attributes and corresponding levels. In most application four to six attributes are selected (Birol et al. 2006; Breustedt et al. 2008; Broch and Vedel 2012). For example in the case study *Farmers' valuation of incentives to produce GM-free milk: insights from a Discrete Choice Experiment in Germany* (chapter 2), we used four scheme attributes (feedstuff monitoring, advice, feed procurement and a price premium) to keep complexity within limits. Based on comprehensive experience in conducting discrete choice studies, Auspurg and Liebe (2011) recommend to select not more than nine attributes to construct alternatives. The selection of attributes is often fraught with many challenges and involves extensive inquiry to the analyst. Focus group discussions, comprising literature review and consultation of experts are common ways to identify what is generally accepted as appropriate attribute. In the above mentioned case study discussions with dairy companies aiming to implement a scheme for GM-free milk production were carried out to confirm if the attributes derived from literature are practical. Once attributes are identified, a researcher must assign them levels to express a range of variation in the context being studied. Alike the attributes also the levels have to be realistic and practically achievable. To measure linear effects, a number of three levels are at least required. Generally, the number of attribute levels does not necessarily be equal for all attributes, but it might be that a relative higher number of levels lead to a higher significance of the corresponding attribute (Wittink et al. 1982). Different numbers of levels are used in the presented case studies. For example, the price for the pork cutlet in consumer choice sets (see chapter 4) varied between six levels to capture the price range between conventional reference price and a maximum price for organic pork cutlet. The use of qualitative and quantitative levels is convenient, but qualitative levels imply a rising number of parameters to be estimated. In some cases the use of qualitative

levels is not avoidable with regard to the research question, e.g. the characteristics of piggy floors have to be included as “solid floor without bedding”, “straw in part of barn area” and “straw in full barn area”.

Having determined the number of alternatives within a choice set, selected the attributes and identified the number of corresponding levels, the researcher has to combine the components into alternatives in an efficient way. Since experimental designs are fundamental for discrete choice experiments and furthermore for the quality of data obtained from its application, a number of authors emphasize the importance of design efficiency. In general, a factorial design (also known as full factorial design) is the enumeration of all possible combinations of attribute levels and such a design guarantees that all attributes and thus all parameters of interest are truly independent from one another implying zero correlation between them (Louviere et al. 2000). A full factorial design allows the estimation of all main effects, two-way interactions and higher order interactions. The choice experiment designed in chapter 1 comprises four attributes, three of them with three levels and one with four levels combined into two alternatives per choice set yielding a total of 11664 combinations $[(3*3*3*4)^2]$. Obviously it is not useful to confront survey participants with all combinations; hence the use of a full factorial design is only practical for problems with restricted numbers of attributes and levels. Instead, strategies are employed to reduce the number of choice sets, such as using fractional factorial designs and/or blocking the design without sacrificing relevant information. Randomly chosen fractions of the full factorial design might cause correlation between attributes and produce inefficient designs. However, design efficiency is determined by four properties, namely *level balance*, *orthogonality*, *minimal overlap* and *utility balance* (Huber and Zwerina 1996). *Level balance* is the requirement that each level occurs equally often within each factor, which means that for example one level of a three-levelled attribute should occur in one-third of all cases. *Orthogonality* is satisfied when the attributes are uncorrelated, thus the multi-collinearity of levels is as small as possible. This property is crucial, since the absence of correlation allows identifying and measuring precisely which attribute drives the change in utility independent from each other. *Minimal overlap* means that the levels of attributes should be the same within a choice set only to a minimum since the contrasts between attribute levels are only meaningful as differences within a choice set. If the criteria of level balance, orthogonality and minimal overlap are satisfied, utility balance should be achieved. A *utility balanced* choice set means that the choice options are almost equally attractive to the decision maker (Huber and Zwerina 1996). Louviere et al. (2000) stated that an orthogonal

fractional design is not always optimal from a statistical point of view. Orthogonal designs reduce the correlation between attributes whereas optimal designs aim to maximize the amount of information obtained from a design and be statistically efficient. In the present dissertation the orthogonal design was created by means of the software SPSS 19 using the command *orthoplan*. After generating the fractional factorial design the yielded combinations of alternatives have to be checked for dominance of one alternative over the other in the same choice set. Furthermore the goodness of the orthogonal design has to be determined by calculating design efficiency. The most prominent measures to evaluate design efficiency are provided by Kuhfeld et al. (1994). It is common to calculate the D-efficiency value, which is a function of the geometric mean of the eigenvalue. Maximizing the D-efficiency criterion is similar to minimizing the variance of coefficient estimates in a linear model, or the inverse of the information matrix $(X'X)^{-1}$. D-efficiency values above 90 indicating a satisfying experimental design compared to the value of 100 obtained from a full factorial design (Kuhfeld 2004). Other measures (A-efficiency or G-efficiency) can be used alternatively, but the D-efficiency has the advantage of being invariant under different codings (Kuhfeld et al. 1994). The case studies in the previous chapters achieved D-efficiency values from 95.3 (chapter 3) to 99.2 (chapter 4).

To keep the survey effort within limits, each respondent is confronted with a number of choice sets yielded from the fractional design. Presenting decision makers with all possible choice sets from a full factorial is not practical since this may place a cognitive burden on respondents and lead, in turn, to unreliable estimates. In literature different numbers for the optimal number of choice sets can be found. Backhaus et al. (2008) recommend not confronting respondents with more than 12 to 15 choice sets. A study carried out by Johnson and Orme (1996) showed that it does not increase the error term asking at least 20 choice tasks in a choice-based conjoint analysis (CA). A number of six choice sets per respondent were recommended by Chung et al. (2011) who conducted several tests to reveal the optimal number of choice sets in a questionnaire. The authors emphasize the importance of pre-testing since the optimal number changes according to data and model specification. The number of choice sets used in the present case studies ranged from four choice sets in “*Dairy farmers’ support of horizontal cooperation among dairy processors: conceptual model and empirical test*” (chapter 4) to seven and eight sets per respondent in the study “*Farmers’ valuation of incentives to produce GM -free milk: insights from a Discrete Choice Experiment in Germany*” (chapter 2). It is either appropriate to select choice sets randomly from the total number of

choice sets yielded by the orthogonal design or to break down the design into different blocks, where each block is then given to a different respondent (Auspurg and Liebe 2011). The use of a choice experiment in a survey should be accompanied by a precise introduction to the choice task and an ex-ante explanation of attributes. A so-called cheap-talk script is one attempt to avoid hypothetical bias (inconsistency between hypothetical behavior and behavior under real economic consequences) and in turn increase validity of survey data. The beneficial effects on reliable preference estimates were among other confirmed by Tonsor and Shupp (2011). The appropriate sample size for a choice experiment is not clearly defined in literature. Although theory exists as to the calculation of the sample size requirements for stated choice data, it does not address the issue of minimal sample size requirements in terms of statistical power of hypothesis tests on the coefficients (Bekker-Grob et al. 2015). Bennet and Adamowicz (2001) recommend answering each block of a choice design by 50 respondents, whereas Lancsar and Louviere (2008) mentioned that “*one rarely requires more than 20 respondents per questionnaire version*”. Bekker-Grob et al. (2015) reviewed 69 studies related to health care employing DCE and showed that a limited sample size prevents detection of smaller effects. Not all of the case studies in the present dissertation achieved a desired sample size due to low response rates, non-completion of questionnaires or protest responses³³. For example the survey for the case study The Role of NUV for farmers’ acceptance of dairy cattle welfare scheme (chapter 3) yielded only a limited number of 78 sufficiently completed questionnaires for analysis of farmers’ acceptance of a farm animal welfare scheme. Although studies exist that rely on smaller sample sizes (Garrod and Willis 1998), results have to be interpreted with caution.

8.4 Evaluation Methods

The conditional logit (CL) model

To make discrete choice models operationally tractable, a number of axioms have been developed to condition the interpretation placed on the empirically identified selection probabilities. The conditional logit model is the most basic model with strong assumptions and a closed form solution resulting in a simple estimation and is thus widely used (Hensher et al. 2005).

³³ Protest responses are responses with no variance, i.e. the same choice occurs independent of attribute level or in all situations the status quo is chosen.

Respondents face different choice sets including a number of distinct alternatives from which they are asked to choose the most preferred one. Based on the actual choices obtained from a sequence of choice situations, the likelihood to select a certain alternative can be computed. Following the RUT approach explained in 8.2. the utility obtained from the chosen alternative j in situation t has the general form:

$$(8.7) \quad U_{njt} = \gamma_n V_{njt} + \varepsilon_{njt}$$

where V_{njt} is the vector of observed variables that include the attributes of alternatives, for example requirements of farm animal welfare schemes (FAW), and further farm and farmer characteristics. The corresponding coefficient γ_n is assumed to be constant over all respondents, implying that only variances in preferences with respect to observed variables can be incorporated into the model. The random term ε of this model is assumed to be independent and identically distributed (IID) extreme value type 1 (Gumbel distribution). The Gumbel distribution is usually used to model the maximum of a number of samples of various distributions and can be defended as an approximation to the normal density (Ben-Akiva and Lerman 2000). This IID condition implies that the variances of the random components of utilities and all covariances are set to zero since the alternatives are independent. An important restrictive property is reflected by the IID condition, namely the independence from irrelevant alternatives (IIA) axiom (Louviere et al. 2000). This axiom states that the relative odds of choice for any alternative are the same independently of the absence or presence of other alternatives available³⁴. In other words, if some alternatives are removed from a choice set, the relative choice probabilities from the reduced choice set are unchanged (Ben-Akiva and Lerman 2000). For the set of attributes that are not observed, this amounts to assuming that all the information in the random components is identical in quantity and relationship between pairs of alternatives and across all alternatives; hence the IID condition (Hensher et al. 2005). In the case that the IIA assumption reflects reality, considerable advantage is gained, that is, the estimation of parameters consistently on a subset of alternatives. A well specified model

³⁴ Train (2003) explains this assumption with the blue bus / red bus problem: Individual i has to choose between a car and a blue bus with the similar probability $P_c = P_{bb} = 0.5$ such that the ratio of probabilities is equal to one. Suppose a red bus is introduced and the individual behaves totally indifferent towards the two types of busses ($P_c = 0.5$; $P_{bb} = 0.25$; $P_{rb} = 0.25$). According to the IIA assumption the probabilities had to be 0.33 for each, the car, the blue bus and the red bus. IIA implies that the ratio of probabilities remains at one, whether or not the red bus exists.

capturing for all sources of correlation between alternatives, that only white noise remains, can therefore be seen as a positive outcome (Train 2003).

To test the IIA property Hausman and McFadden (1986) suggest a specification test, namely, the Hausman test. Under the assumption of IIA no systematic change in coefficients would be expected if one alternative will be excluded from the model. In a first step an unrestricted model is estimated comprising all alternatives, afterwards a model is estimate synonymous with the alternative hypothesis on a subset of alternatives. If the Hausman test displays a negative result due to a small sample size a “Suest” test procedure³⁵ can be used. In case of violated IIA assumptions, it is possible to alternatively apply a probit model (see Breustedt et al. 2008). Further the assumption of linearity for linear specified attributes has to be tested. To this end, the highest and the lowest level of attribute variables with three levels in total are incorporated effects-coded into the model³⁶. The assumption of linearity holds if the ratio of estimated parameters associated with the lower level and the higher level is equal to the ratio of the actual level values (Hensher et al. 2005). This ensures that the change of an attribute by one unit, indifferent in its direction, implies a change in choice probability of choice with the same magnitude.

The IIA property is an important disadvantage of the conditional logit model. Another shortcoming is the assumption that all respondents have the same preferences for attributes and that individuals’ tastes are explained by their means only. Over the last decade a number of evaluation techniques for DCE have been developed to overcome the IIA restriction. For example, generalized extreme value models (GEV) constitute a class of models that exhibit a variety of substitution patterns (Train 2003). A widely used type of such models is the nested logit model, where alternatives are placed into nests with unobserved factors having the same correlation for all alternatives within a nest and no correlation of alternatives in different nests. Other group of models relaxing the IIA assumption are probit models and mixed logit models. Depending on the research question and complexity of the choice situation, extensions of the standard logit model can be applied. Usually the employment of mixed logit models is appropriate to capture heterogeneity across members of the observed population.

³⁵ The SUEST test is a more general version of the Hausman test.

³⁶ According to Hensher et al. (2005) the test of linearity requires to set the medium level as base level equal to minus 1 and the other levels as zero (low level) and one (high level).

Mixed logit models

Accounting for heterogeneity is useful to explain choice behavior, since preferences vary due to individual characteristics, experiences, contexts and many more. Neglecting preference heterogeneity when it is actually existent leads to biased parameter estimates, and as such to misleading predictions of attribute valuation resulting in unreliable demand, marginal welfare and total welfare estimation (Greene 2008). The source of preferences varies according to the target population as object of investigation. For instance, consumers' purchase decision on food products, which is an extensively investigated issue, are often influenced by many other factors than the products attributes, such as socio-economic factor e.g. gender and income, attitudes towards quality, production processes etc. or other information about the product that is available to the consumer. Farmers' preferences are additionally determined by different farming systems, different production objectives or market segments, but an increasing number of studies aim to shed light of the influence of farmers' attitudes on their choice behavior (Davies and Hodge 2006; Ruto et al. 2008; Ruto and Garrod 2009). Controlling for influences of this type can be done by incorporating explanatory variables into the deterministic part of the utility function (compare formula 8.2.). However, it is very likely that preference heterogeneity will remain even after accounting for differences in observed individual characteristics (Bhat 2000). Therefore model specifications that are able to capture unobserved heterogeneity are most suitable to increase explanatory power of models applied to heterogeneous samples.

Random Parameter Logit (RPL) Model

The random parameter logit (RPL) model is highly flexible i.e. it can approximate any random utility model that has the general form of function already introduced in 8.5. Unlike the conditional logit model this specification allows for random preference variations and does not impose the IIA assumption. Differentiating the RPL model from other specifications is the assumption that the unobserved taste coefficient vector (γ_n) varies in the population with density $f(\gamma_n|\theta)$. The population parameters θ describe this distribution of individual parameters (e.g. mean and covariance of the γ 's). Thus two sets of parameters have to be taken into account. Conditional on γ_n the logit specification for farmer n choosing the most preferred alternative j^* in choice situation t can be written as:

$$(8.8) L_{nj^*t}(\gamma_n) = \frac{e^{\gamma_n x_{nj^*t}}}{\sum_{j=1}^J e^{\gamma_n x_{njt}}}$$

Given that β_n is unknown to the researcher, the unconditional probability has to be employed which is the integral of conditional probability over all possible values of β_n (Train 2003).

$$(8.9) P_{nj} = \int L_{nj^*t}(\gamma_n) f(\gamma_n|\theta) d\gamma_n$$

The distribution of γ_n has to be specified by the analyst with regard to the expectations about the individuals behavior. In most applications the specification of the distribution for the coefficients follows a normal [$\gamma \sim N(b, W)$] or lognormal distribution [$\ln \gamma \sim N(b, W)$] if it is desirable to restrict the sign of the coefficient to be either positive or negative for all individuals (Hole 2007). In particular for the price variable the assumption of normal distributed coefficients implies that some share of the population actually prefer higher prices or lower compensation payments. A normal distribution is also inappropriate for the part-worth of a desirable attribute that is valued by all decision makers or an undesirable attribute that is disliked (or ignored) by all of them (Train and Sonnier 2005). In several empirical applications of the mixed logit (ML) model, for example Anastassiadis et al. (2012), the price coefficient is assumed to be fix since identification is empirically difficult if all coefficients are allowed to vary (for further explanation see Ruud (1996)). The fixation of the price coefficient implies that the WTP or WTA, which is the ratio of the attribute's coefficient to the price coefficient, is thereby distributed the same way as the attributes coefficient (Revelt and Train 1998). The mixed logit model also allows efficient estimation if each individual evaluates several choices. Given that case, it is assumed that tastes vary across decision-makers but not across repeated choices. The only difference to a model with only one choice is that the integrand involves a product of logit formulas, one for each choice situation. The probabilities do not exhibit the IIA property of the standard logit model and different substitution patterns are may be obtained by appropriate specification β_n as having both a mean and a standard deviation. A statistically significant parameter estimate for the standard deviation of random parameters suggests the existence of heterogeneity. Given that, the integral does not have closed form solution it cannot be calculated exactly and therefore the probability has to be approximated through simulation. Although the random parameter logit (RPL) model accounts for unobserved heterogeneity, it fails to explain the sources of it. Introducing interaction terms between individuals' characteristics and choice attributes is a way to trace existing heterogeneous preferences (compare chapter 2). However, this might be a limitation since multicollinearity is a common problem arising from too many interactions. Boxall and Adamowicz (2002) suggest the usage of latent class models to investigate the source of heterogeneity.

Latent Class (LC) Model

McFadden (1986) recognized the importance of incorporating latent variables into choice models to understand respondents' behavior. He emphasized that the critical constructs in modelling cognitive decision processes are perceptions of beliefs regarding the objects of choice, generalized attitudes or values, decision protocols that map preferences into choices and further behavioral intentions for choice. The technique of creating interactions between attributes of alternatives and characteristics of the decision maker is restrictive because the key characteristics have to be identified a priori and thus have to be observable by the analyst (Boxall and Adamowicz 2002). More appropriate to explain heterogeneity among decision makers are latent class models (compare chapter 2). In contrast to the RPL model, which specifies the parameters to follow a continuous joint distribution, the mixing distribution $f(\gamma_n|\theta)$ in a latent class model is assumed to be discrete, with β_n taking a finite set of distinct values (Train, 2003). Heterogeneity is captured by sorting population members into distinct classes c ($c = 1, \dots, C$), each of which is associated with a corresponding parameter vector in the corresponding utility. Within a class the taste of the members is homogenous but heterogeneous preferences between the classes. Since the classes are latent, they are not observable by the researcher. The central behavioral model is a logit model with independent choice probabilities. Given that farmer n belongs to class c the probability of choosing alternative j^* in choice situation t is therefore:

$$(8.10) \text{ prob } ((n, j^*t|c)) = \prod_{t=1}^T \frac{e^{\gamma_{c}x_{nj^*t}}}{\sum_{j=1}^J e^{\gamma_{c}x_{njt}}}$$

In this formulation β_c is a class specific coefficient vector included to capture heterogeneity in preferences across classes. In contrast to the random parameter logit (RPL) model, which allows the parameters to vary across farmers, the latent class model assumes parameters to vary across classes. The class membership depends on the characteristics of the decision maker. For example, the membership of farmers belonging to a class of adopters or non-adopters of a GM-free scheme depends on e.g. the attitude towards the cultivation of GM crops and expectation about consumers' WTP for GM-free milk (see chapter 2). Regarding these membership variables, there exists a certain probability that an individual n belongs to a specific class c (Greene and Hensher, 2003). For farmer n a latent membership likelihood function can be described using the conditional logit (CL) form.

$$(8.11) \quad \text{prob}(c) = \frac{e^{\Gamma_c z_n}}{\sum_{c=1}^C e^{\Gamma_c z_n}} \Gamma_c = 0$$

where the vector z_n contains both, farm and farmer characteristics as well as latent attitudinal variables that are assumed to explain the decision behavior and Γ_c is a vector of parameters. The probability for farmer n belonging to a specific class ranges between zero and one and sums up to one for all possible classes the farmer might belong to. The parameter estimates of each class have to be evaluated in relation to the c^{th} parameter vector, thus it is normalized to zero (Greene 2008).

The latent segmentation model represents a model locate within a range of approaches. On the one end of the range is the single segment case which assumes perfect homogeneity of preferences, and at the other end is the case where each individual is considered a segment (Boxall and Adamowicz 2002). While one expects improvement in the log likelihood values as additional classes are added to the model, the model fits must be penalized for the increase in the number of parameters that in turn increase due to additional classes. The optimal number of classes is achieved when additional classes provide only little information.

The adjusted R^2 penalizes the loss of degrees of freedom that occurs when a model is expanded. There is, however, some question about whether the penalty is sufficiently large to ensure that the criterion will necessarily lead the analyst to the correct model as the sample size increases. The fit measures Akaike Information Criterion (AIC) and minimum Bayesian Information Criterion (BIC) decline as R^2 increases, but degrade if the model size increases. These measures place a premium on achieving a given fit with a smaller numbers of parameters per observation.

Among others Swait (1994) recommends the AIC and the BIC to which are calculated as follows:

$$(8.12) \quad AIC = \{-2(LL - k)\}$$

$$(8.13) \quad BIC = \{-LL + \left(\frac{k}{2}\right) \ln(N)\}$$

where LL is the log likelihood value of the model and k the number of free model parameters. Unlike the AIC the formula shows that the BIC accounts additionally for the sample size N , i.e. gives a larger model size penalty. To avoid an overestimation of the optimal number of classes it is recommended to evaluate the number of classes based on both information criteria. Some authors are questioning the discrete approach and suggest latent class models to

understate the extent of heterogeneity in choice data (Elrod and Keane 1995; Allenby and Rossi 1999).

Goodness of model fit

To evaluate the overall model fit usually measures for coefficient determination are applied. Usually R^2 is calculated in linear regressions, a measure for the proportion of variance explained by the model. However, for models estimated by means of Maximum Likelihood estimation this measure is not appropriate, since estimates drawn from an iterative process are not calculated to minimize variance. Nevertheless, several pseudo- R^2 s have been developed to evaluate the goodness of fit of logistic models. The pseudo- R^2 according to McFadden (1974) is defined by one minus the ratio of the Log-Likelihood (LL) functions of the estimated model (LL_v) and a base model (LL_0) only including the constant:

$$(8.14) \quad McFadden - R^2 = 1 - \frac{LL_v}{LL_0}$$

Other approaches for pseudo- R^2 s were developed by Cox and Snell (1989) and Nagelkerke (1991). Being the most popular goodness of fit measure for logistic models, the McFadden pseudo- R^2 was employed to evaluate the model fit in the previously presented case studies. Referring to Louviere et al. (2000) a value between 0.2 and 0.4 are considered as indicative for an extremely good model fits. Hensher et al. (2005) suggest that a pseudo- R^2 value that ranges between of 0.3 and 0.4 can be interpreted as an R^2 of a linear model between 0.6 and 0.8.

Besides the Pseudo R^2 other statistical tests are usually applied to assess the goodness of fit of a model. A Likelihood Ratio (LR) test can be used as a device for testing a model restriction. More precisely, the LR-test is based on a comparison of the estimated model with a model where one or more parameters are fixed to zero, i.e. omitted from the model specification. Following Greene (2008) the test statistics is given by:

$$(8.15) \quad LR = -2(\ln LL_1 - \ln LL_2)$$

with LL_1 depicting the likelihood value for the model including only significant variables and LL_2 represents the likelihood value of the full model including all relevant variables. The test statistic follows a χ^2 -distribution with degrees of freedom equal to the number of required restrictions. Additionally a Wald test (χ^2 -distributed) can be employed to test the H_0 hypothesis that a single coefficient equals zero and thus has no influence on the probability of choice

(Cameron and Trivedi 2009). The precondition for the use of a Wald test instead of a likelihood ratio test is the estimation of robust standard errors, which are according to White (1980) heteroscedasticity-consistent.

Estimation of willingness to accept (WTA) or willingness to pay (WTP)

Increasingly, discrete choice models are used to derive the amount of money an individual requires for acceptance (or is willing to pay) to put up with something that might produce disutility (to obtain some benefit in terms of utility). In a model where each attribute in a utility expression is associated with single taste weight, the ratio of two utility parameters, where one of them is measured in monetary units, is an estimate of WTA (or WTP).

The WTA estimates reflect the price premium requested to compensate farmers for the loss of utility from implementing the production requirements. The marginal effects can be interpreted as the change of the outcome variable (here the likelihood of choice) due to an infinitesimal change of independent variables. For discrete variables it is not appropriate to calculate the marginal effect in terms of infinitesimal changes. Thus, as a preliminary step the marginal effects are calculated at the mean of the sample and subsequently a discrete change of the variable of interest is simulated that leads to a change in the corresponding probability. The difference of both probabilities represents the marginal effect of the dummy variable or categorical variable. By setting the marginal effect of an explanatory variable (x_j or z_n) in relation to the marginal effect of the price premium (p_{jn}), the WTA for that variable is denoted in monetary terms.

The formal expression of the WTA for a scheme attribute x_j is:

$$(8.16) \quad \text{marginal WTA for } x_j = \frac{\Delta WTA}{\Delta x_j} = \left(\frac{\sum_{n=1}^N \frac{\Delta \text{prob}_{jn}}{\Delta x_j}}{N} \right) / \left(\frac{\sum_{n=1}^N \frac{\partial \text{prob}_{jn}}{\partial p_{jn}}}{N} \right)$$

The calculation of the willingness to accept using the ratio of attribute coefficients is frequently used in discrete choice studies. Since attribute variables are random in a mixed logit (or random parameter) model, the WTA estimate is a random variable itself. In their paper Scarpa et al. (2008) comparing two different approaches to estimate consumers' WTP in discrete choice models. The standard approach to estimate respondents' willingness to pay (WTP) or willingness to accept (WTA) is to assume a distribution for the coefficients and derive WTP for an attribute as the ratio of attribute coefficient and the marginal utility of the monetary

variable (e. g. compensation payment or product price). Values of the price coefficient that are close to zero cause the ratio to be exceedingly large such that the mean and the variance are raised artificially. Assuming the price coefficient to be constant, allows the distribution of WTP to be calculated easily from the distribution of the attribute of interest, since both distributions take the same form. Providing accurate results, confidence intervals for the estimated WTP and WTA values were calculated using the delta method according to Greene (2008). Following Hole (2007) the confidence intervals can be computed based on the estimated coefficient α_x of the observed variable x , the price coefficient α_p of the monetary variable and their variances and covariances.

(8.17)

$$\text{var}(WTA_x) =$$

$$\left[\left(-\frac{1}{\alpha_p} \right)^2 \text{var}(\alpha_x) + (\alpha_x/\alpha_p^2)^2 \text{var}(\alpha_p) + 2\left(-\frac{1}{\alpha_p}\right)(\alpha_x/\alpha_p^2) \text{covar}(\alpha_x, \alpha_p) \right]$$

$$(8.18) \quad WTA_x \pm \alpha_x/2 \sqrt{\text{var}(WTA_x)}$$

The application of the delta method is a common procedure to obtain confidence intervals of marginal WTA values (Ruto and Garrod 2009; Espinosa-Goded et al. 2010; Liljenstolpe 2008).

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Curriculum Vitae

Name	Julia Anette Schreiner
Date of birth	8 th of March 1981
Place of Birth	Kiel, Germany
Nationality	German

Employment Experience

Since 06/2011	Barista at Café und Mehr, Siegbert Last, Bad Segeberg
Since 08/2014	Research Assistant at the Department of Agricultural Economics, University of Kiel, Chair of Farm Management and Production Economics
04/2012 – 08/2014	Research Assistant at the Department of Agricultural Economics, University of Kiel, Chair of Dairy and Food Industry Economics
11/2010 – 05/2011	Research Assistant at the Institute for Food and Resource Economics, Chair of Business Management, Organization and Information Management, Project Work “NetGrow“, University of Bonn
08/2010 – 07/2011	Customer support at Phoenix Television Channel, Mainz
06/2010 – 06/2011	Research Assistant at the institute of Organic Farming, University of Bonn
01/2010 – 05/2010	Sales assistant at Basic A.G., Bonn
08/2002 – 09/2009	Sales assistant at H & M Hennes & Mauritz AB, Kiel

Education

10/2009 – 03/2012	M.Sc. in Food and Resource Economics, Rheinische Friedrich-Wilhelms- University of Bonn Subject of the thesis: The Use of Steviol Glycosides in the Dairy Industry: Opportunities and Challenges
04/2004 – 03/2009	B.Sc. in Food Science, Christian-Albrechts-University of Kiel Subject of the thesis: Market Potential for Organic tea from India: a business survey
10/2003 – 03/2004	Study in Biology, Christian-Albrechts-University of Kiel
04/2002 – 10/2002	Study in Indology, Christian-Albrechts-University of Kiel
06/2001	High School degree: Abitur, Käthe Kollwitz Gymnasium Kiel