# ANALYSING FARMERS‘ PREFERENCES FOR COLLABORATIVE ARRANGEMENTS: AN EXPERIMENTAL APPROACH

Jan-Henning Feil

Department für Agrarökonomie und Rurale Entwicklung,
Georg-August-Universität Göttingen

Friederike Anastassiadis

Department für Agrarökonomie und Rurale Entwicklung,
Georg-August-Universität Göttingen

Oliver Mußhoff

Department für Agrarökonomie und Rurale Entwicklung,
Georg-August-Universität Göttingen

Philipp Kasten

Mecklenburgische Versicherungs-Gesellschaft a.G.,
Hannover

Kontaktautor: jan-henning.feil@agr.uni-goettingen.de

GEWISOLA 2015

Schriftlicher Beitrag anlässlich der 55. Jahrestagung der
Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e.V.
**„Perspektiven für die Agrar- und Ernährungswirtschaft nach der Liberalisierung“**

Gießen, 23.-25. September 2015

## ANALYSING FARMERS' PREFERENCES FOR COLLABORATIVE ARRANGEMENTS: AN EXPERIMENTAL APPROACH

**Abstract**

This paper analyses farmers' preferences for farm-level collaborative arrangements (CAs) based upon a discrete choice experiment conducted in Germany. A mixed logit and a generalized multinominal logit model are used to determine whether farmers' decisions to establish a CA with a potential partner are influenced by non-monetary attributes like the age of the partner, the years of acquaintance with the partner or the production activities of the partner. Moreover, a monetary attribute is included to calculate the average individual's willingness-to-pay or 'implicit price' for a change in each of the non-monetary attributes. The results show that farmers' preferences for CAs increase, the closer their age is, the more years of (positive) acquaintance between them exist and the more similar their production activities are.

**Keywords**

Farm-level collaborative arrangements, discrete choice experiment, generalized multinomial logit, willingness to pay

### 1. Introduction

Currently the agricultural sector is globally exposed to strong changes in its general conditions, resulting in increasing pressure on costs and margins for farms. The costs for machinery and labour have especially escalated dramatically in recent years (e.g. NASS, 2015). Since both machinery and labour can often just be adopted in discrete amounts, such as the investment in one tractor or the recruitment of one worker, expanding production would be one way to handle the associated rise in fixed costs (e.g. JOHNSON and RUTTAN, 1994). However, this strategy is not always appropriate or feasible in agriculture because of insufficient access to land and capital. Furthermore, the high (and further increasing) level of uncertainty in farming due to its weather-dependent nature often requires quick decision-making and knowledge, which cannot easily be delegated to workers (e.g. JOHNSON and RUTTAN, 1994). This can be seen as one of the main reasons for the prevalence of family owned and operated farms in many countries all over the world (e.g. ALLEN and LUECK, 1998; DEINIGER and BYERLEE, 2012).

For many farms, an alternative strategy to handle these increasing fix costs is to share the associated assets and labour with other farms. In many European countries, farms are organized in collaborative arrangements (CAs) on a comparatively formal basis, that is, in the form of inter-farm cooperation, machine cooperatives, machine rings and the use of sub-contractors. This applies particularly to Germany, Great Britain and Sweden (e.g. CRAIG and SUMBERG, 1997; DE TORO and HANSSON, 2004; DOLUSCHITZ, 2001; SAOS, 2008). In Canada, some farmers are likewise organized in formal machinery cooperatives, such as 47 CUMA's (e.g. HARRIS and FULTON, 2000). In the United States, where farms traditionally share equipment and labour on a more occasional basis, formal and routine-based CAs are also getting more and more popular in recent years (e.g. ARTZ, 2014).

Most of the existing literature on farm-level CAs focuses on the respective economic advantages of their members due to access to economies of scale, based on exemplary case studies in different countries (ANDERSSON et al., 2005; ARTZ et al., 2010; AURBACHER et al., 2011; DE TORO and HANSSON, 2004; NIELSEN, 1999, WOLFEY et al., 2011). LARSÉN (2010) confirms this by empirically analysing the efficiencies of collaborating and non-collaborating Swedish farms by using FADN data, complemented with survey data. She finds that the average efficiency is indeed higher for collaborating farms than for non-collaborating farms, which applies to both crop and livestock farms.

The question arises, as to why farm-level CAs are still so rare in practice despite of the potential economic advantages of sharing equipment and labour with other members (e.g. ARTZ, 2014). AURBACHER et al. (2011) calculate the economic implications of a CA between five relatively small arable farms in south Germany and come to the result, that one reason that inhibits inter-farm machinery use could be path dependency. LAGERKVIST and HANSSON (2012) conduct a coordination game with farmers and find that personal factors like intolerance of ambiguity can influence famers' willingness to establish CAs. Apart from that, all of the aforementioned studies emphasize that a further important reason for not establishing CAs is the risk of future potential conflicts with the potential partner, like problems of timeliness, free-riding and opportunism (e.g. ARTZ, 2010 et al.). These conflicts might moreover result in substantial additional transaction costs for the members of a partnership, which might (partially) offset the economic advantages resulting from access to economies of scale. However, the actual influence of these potential conflicts on the decisions of farmers to establish CAs in the first place has not been investigated yet.

Against the background of this research gap, the objective of this paper is to analyse farmers' preferences for establishing CAs under explicit consideration of non-monetary factors that allow conclusions on the functioning of the future partnership. In this context, an empirical investigation based on historical data would be of limited explanatory power, as it is challenging or impossible to clearly distinguish the influencing factors of farmers' decisions to establish collaborative agreements in retrospective. Experiments can provide a solution to this issue as they collect data under controlled conditions. In particular, discrete choice experiments (DCEs) allow for the determination of preferences for action alternatives without explicitly asking for them (e.g. TRAIN, 2009). By relating the respondents' choice behaviour to the attributes of the action alternatives and the respondents' individual characteristics, complex structures of the decision-making process can be revealed (e.g. LOUVIERE et al., 2010). DCEs have already been successfully applied to analyse farmers' preferences, including different technologies (e.g. BREUSTEDT et al., 2008) or agri-environmental schemes (e.g. ESPINOSA-GODED et al., 2010), and could thus also be considered as an appropriate methodological approach to investigate farmers' preferences for CAs.

Therefore, the data for the analysis was gained through a DCE that was carried out by 107 German farmers in the year 2014. The farmers had to make a choice between two alternative collaboration partners and the opt-out alternative of no collaboration. The collaboration partners were specified by non-monetary attributes that varied over the different choice sets, like their age, the years of acquaintance with the respondent and their production activities. Moreover, the expected increase in profit of the respondent for establishing a collaboration with the respective partner was included as a monetary attribute, to allow for calculating the average individual's willingness-to-pay (WTP) or 'implicit price' for a change in each of the non-monetary attributes. Since WTP values are upwards biased when not considering for scale heterogeneity (TRAIN and WEEKS, 2005), we apply the generalized multinomial logit (GMNL) model introduced by FIEBIG et al. (2010) to identify residual preference heterogeneity. The advantage of the GMNL over the more generally applied mixed logit (ML) model is that, in addition, it accounts for heterogeneity in the scale of the error term. That means it is possible to control for respondents with nearly lexicographic preferences and respondents showing very “random” behaviour. To our knowledge, in DCE studies with an agricultural focus GMNL models are not habitually used.

The rest of the paper is structured as follows: In section 2, the hypotheses with regard to farmers' preferences for CAs that shall be tested by means of the DCE are derived from the literature. The design of the questionnaire, which includes the DCE, as well as the descriptive data are described in the subsequent section. Afterwards, the theoretical background of the analysis methods is explained in section 4. Finally, the results of the DCE are presented in section 5. The paper ends with some conclusive remarks (section 6).

## 2. Farmers' motives and obstacles to establish collaborative arrangements

A central motive for a farmer to establish CAs is the improvement of the own future profitability of his/her farm. This motive arises from the expectation that the participation in farm-level CAs, in which resources like equipment and labour are shared, and in which the purchasing of inputs and the marketing of outputs are coordinated, involve an access to internal and external economies of scale (e.g. ALLEN and LUECK, 1998; VALENTINOV, 2007). Internal economies of scale arise from improvements in technological efficiency, that is, an ability to produce more output with the same inputs or to produce the same output with fewer inputs (e.g. VARIAN, 1992). Sharing machinery tends to increase the area under cultivation serviced by the machinery, for instance one mutual combine tractor instead of two, resulting in reduced average costs for a given amount of output. Sharing can therefore make newer, larger, more technologically advanced equipment economical. In addition, group members can improve labour productivity by coordinating tasks to reduce duplication and allow for task specialization. This effect is widely confirmed by many normative model-based case studies (e.g. ANDERSSON et al. 2005; DE TORO and HANSSON, 2004), by surveys (e.g. ARTZ et al., 2010; HEIN et al., 2011) as well as by empirical investigations of the technical efficiencies of farms in CAs (LARSÉN, 2010). External economies of scale are related to advantages larger farms may have in accessing inputs and arable farm land, obtaining and negotiating terms of credit, storage and services as well as marketing and distribution of outputs (e.g. JOHNSON and RUTTAN, 1994; MCBRIDE, 2003). Although these advantages of size are difficult to verify empirically for farm-level CAs, they are nonetheless widely confirmed in surveys of farms already working in collaborations (e.g. ARTZ et al., 2010; HEIN et al., 2011). One can expect that in reality farmers are carefully estimating the potential increase in future profits resulting from internal and external economies of scale prior to making the decision to start a CA with a potential partner. This leads to the following hypothesis:

*H1 (profit increase): The higher the expected increase in profits, the higher is a farmer's preference to establish a CA.*

Besides the potential positive economic effects arising from internal and external economies of scale, CAs might also produce manifold conflicts between its members (e.g. ARTZ et al., 2010; HOLDERNESS, 2003). Examples are timeliness concerns, moral hazard problems, cost of collective decision-making and opportunism. These conflicts can imply additional considerable transaction costs and risks, which partially offset the economic advantages from the access to economies of scale. However, it can be expected that farmers are not considering the costs and risks associated with these conflicts directly when they estimate their expected increase (or decrease) of profitability by establishing a CA in advance (cf. H1). This is due to the fact that these costs and risks are very difficult to measure. They may just occur occasionally and they strongly depend upon the (mis)behavior of the potential collaboration partner (e.g. ARTZ, 2014; DE TORO and HANSON, 2004). However, there are suggestions in the literature that these costs and risks can be reduced significantly by choosing a partner who is "like-minded" and with whom there is a high degree of "trust" (e.g. ARTZ et al., 2010; HEIN et al., 2011; LARSÉN, 2007). To operationalize these rather vague, superior and subjective concepts for the DCE, it is assumed that objectified factors exist and which directly affect the individually perceived "like-mindedness" and "trust" between potential collaboration partners. As a result of extensive expert discussions with collaborative and non-collaborative farmers as well as with agricultural consultants prior to the experiment, such objectified factors are the age of the potential collaboration partner, the duration of the acquaintance with the partner as well as the production activities of the partner.[1] Accordingly, a similar age, a longest possible positive acquaintance and similar production activities can be seen as proxies for a high degree of trust and like-

[1] It should be noted that production activities in this context do not refer to the access to potential economies of scale between collaborating farms but to psychological aspects and traditional thinking (e.g. BENZ, 2006). For instance, a pure arable farmer could be reluctant to collaborative with a dairy farmer because of his social upbringing.

mindedness between potential collaboration partners (e.g. HEIN et al., 2011, LARSÉN, 2007). From this, the following three hypotheses can be derived:

*H2 (age): The closer the age of the potential collaboration partners, the higher is a farmer's preference to establish a CA.*

*H3 (acquaintance): The more years of positive acquaintance between potential collaboration partners, the higher is a farmer's preference to establish a CA.*

*H4 (production activities): The more similar the production activities between potential collaboration partners are, the higher is a farmer's preference to establish a CA.*

## 3. The experiment

The questionnaire is divided into two sections. In the first section, the respondents have to conduct the DCE. In the second section, the farmers are asked to answer questions about their risk attitude and their socioeconomic background. In subsection 3.1., the decision situation, the attributes and the respective levels of the DCE are described. Subsequently, the desciptive statistics of the questionnaire are presented in subsection 3.2.

### 3.1. Decisions situation, attributes and levels

In the DCE, the decision-making situation in each choice-set comprises two different and mutually exclusive collaboration alternatives A and B, as well as the status-quo alternative of no CA. The farmers are advised to make a decision between these three alternatives as if it was their personal decision for their own farm. The DCE is adressed to both farmers already working in a CA (collaborative farmers) and farmers who are not (non-collaborative farmers). To ensure comparability of the decision-making situation, collaborative farmers are asked to make the decision as if they would still run their farm without a CA.

According to the four derived hypotheses in section 2, the above-mentioned three decision alternatives are described by the four attributes 'expected average increase in the respondent's profit for the first ten years of collaboration', 'years of positive acquaintance with the potential collaboration partner', 'age of the potential collaboration partner' and 'production activities of the potential collaboration partner'. The levels, within which these attributes vary over the different choice sets, are provided in Table 1. The attributes as well as the levels are the result of extensive expert discussions with collaborative and non-collaborative farmers and agricultural consultants as well as a careful consideration between reality and complexity. It should also be noted that the respondents are asked to assume prior to each choice set that the level of the 'expected average increase in profit' has been determined in extensive calculations prior to the decision under explicit consideration of the production activities of the potential collaboration partner. This means that the attribute 'production activities of the potential collaboration partner' is merely included in the choice sets to additionally account for psychological factors, which could result in (potentially costly) conflicts of interest (cf. section 2).

**Table 1: Attributes and levels in the DCE**

| Attributes | Levels |
|---|---|
| Expected average increase in the farmer's profit for the first ten years of collaboration (in €/year) | 10,000; 20,000; 30,000 |
| Years of positive acquaintance with the potential collaboration partner (in years) | 1; 5; 10 |
| Age of the potential collaboration partner (in years) | 30; 45; 60 |
| Production activities of the potential collaboration partner | Arable farming;<br>Arable farming and animal husbandry;<br>Arable farming and renewable energies |

*Source:* Author's own illustration.

The experimental design of the DCE with two generic alternatives and four attributes with three levels respectively results in a full factorial design of ($4^3_{CA\ A} \cdot 4^3_{CA\ B}$=) 6,561 possible choice sets. To minimize the concomitant and unavoidable loss of information when reducing the full factorial design, an experimental design is used that aims for orthogonality, level-balance and controls for dominant alternatives (for more details on the %MktEx Macro Algorithm employed in this study and implemented in SAS cf. KUHFELD, 2010). Thus, the number of choice sets presented to the participating farmers is reduced to 9. Such a design has a D-efficiency of 100%.

After conducting the DCE, the farmers are asked for information regarding their risk attitude and their socioeconomic background. Following DOHMEN et al. (2011), the farmers' risk attitude is measured by the “general risk question” using an ordinal scale from 0 to 10, whereby 0 represents “not willing to take risk at all” and 10 represents “very willing to take risk”. Hence, farmers evaluate their risk attitude subjectively. The question with regard to the respondents' socioeconomic background relate to factors like age, education and production activities.

### 3.2. Descriptive statistics

The online survey was completed by 107 farmers from all over Germany during May and June 2014 and was brought to farmers' notice through social networks. In addition, students were also asked to make farmers aware of the experiment. On average it took about 23 minutes to complete the whole questionnaire. Table 2 reports personal information and farm characteristics of the participants.

The respondents are 11% female, with an average age of 34 years and a standard deviation of 12 years. 45% of the respondents manage the farm in an executive position and the remaining 55% are farm successors and/or employed on a farm. Overall, 66% hold a college or university degree. On average, they are slightly risk-seeking (μ=5.7; σ=1.7; ordinal scale from 0='not willing to take risk' to 10='very willing to take risk'). The average farm size is 278 hectares with a standard deviation of 424 ha. Furthermore, 64% of the respondents already work within a CA.

**Table 2: Descriptive statistics [a]**

| | |
|---|---|
| **Farmers** | |
| Share of female participants | 11 |
| Average age (in years) | 34 (12) |
| Share of farm managers | 45 |
| Share of participants with an university degree | 66 |
| Average risk attitude (self-assessed) [b] | 5.7 (1.7) |
| **Farms** | |
| Share of farms who generate their main income with farming | 85 |
| Average farm size (in ha) | 278 (424) |
| Share of farms with production activity 'arable farming' [c] | 93 |
| Share of farms with production activity 'animal husbandry' [c] | 81 |
| Share of farms with production activity 'renewable energies' [c] | 35 |
| Share of farmers already working in a collaborative arrangement | 64 |
| **Decision situation** | |
| Number of non-answered choice sets out of 963 choice sets | 0 |
| Proportion of the decisions for cooperation alternative A or B in % | 73 |

*Source*: Author's own illustration.
*Notes:* [a] n=107, standard deviation in brackets.
[b] Ordinal scale from 0 to 10; 0='not willing to take risk at all'; 10='very willing to take risk' (cf. DOHMEN et al., 2011).
[c] Multiple references possible.

On the basis of the descriptive statistics, it becomes clear that the sample is not representative for the population of all German farmers. However, the study aimed to recruit farmers who are diverse regarding their farm structure, instead of generating a representative sample. This is for instance indicated by the large standard deviation of the variable 'farm size'.

## 4. Modelling approach

According to the random utility theory (MCFADDEN, 1974), it is possible to determine an indirect utility function $U_{int}$ for each sampled individual *n*, that is each respondent of the experiment, and each alternative *I*, that is each collaboration alternative, in choice occasion *t* (cf. HENSHER and GREENE, 2003):

$$U_{int} = \boldsymbol{\beta}_n{}'\boldsymbol{x}_{int} + \boldsymbol{\varepsilon}_{int} \qquad (1)$$

$U_{int}$ can be described by *K* observed attributes $\boldsymbol{x}_{int}$.. However, the individual-specific taste parameters $\boldsymbol{\beta}_n$ are not observable. Non-observable individual preferences are considered in the stochastic component $\boldsymbol{\varepsilon}_{int}$, for which we assume an independently and identically distributed (i.i.d.) extreme value distribution.

For the so called ML model, the following definition of $\boldsymbol{\beta}_n$ is assumed:

$$\boldsymbol{\beta}_n = \overline{\boldsymbol{\beta}} + \Delta \boldsymbol{s}_n + \boldsymbol{\Gamma}\boldsymbol{v}_n \qquad (2)$$

where $\overline{\boldsymbol{\beta}}$ is the fixed mean of the assumed distribution for $\boldsymbol{\beta}_n$. The *K*x*M* parameter matrix Δ expresses how the preference of chosing a certain alternative *i* changes due to the influence of *M* individual characteristics $\boldsymbol{s}_n$ in comparison to the reference individual (with taste parameter $\overline{\boldsymbol{\beta}}$) while all other effects remain constant. $\boldsymbol{v}_n$ is a vector of *K* variables for which zero means, known variances and zero covariances are assumed. In our case, $\boldsymbol{\Gamma}$ is a diagonal matrix. Thus, the stochastic parameters are not allowed to be correlated.

As for instance FIEBIG et al. (2010) and KEANE (2006) state, the multinomial logit model and the ML model do not adequatly consider for scale heterogeneity. Therefore, we also introduce the GMNL model here. Following FIEBIG et al. (2010), the abovementioned definition of $\boldsymbol{\beta}_n$ is stretched out in the GMNL model in the following way:

$$\boldsymbol{\beta}_n = \sigma_n[\overline{\boldsymbol{\beta}} + \Delta \boldsymbol{s}_n] + [\gamma + \sigma_n(1-\gamma)]\boldsymbol{\Gamma}\boldsymbol{v}_n \qquad (3)$$

$\sigma_n$ is the individual-specific scale of the error term. FIEBIG et al. (2010) assume a log-normal distribution for $\sigma_n$ with standard deviation τ and mean $(\bar{\sigma} + \boldsymbol{\delta}\boldsymbol{z}_n)$, where $\bar{\sigma}$ is a normalizing constant and $\boldsymbol{z}_n$ is a vector of *L* indiviual-specific variables. $\gamma$ is a weighting parameter that indicates, how variance in unobserved preference heterogeneity varies with scale.

Being a utility maximizer, individual *n* chooses alternative *j* instead of *i* from a given set of alternatives $C_{nt}$ if the following applies: $U_{jt} > U_{it}\ \forall j \epsilon C_n,\ j \neq i$. For a given value of $\boldsymbol{\beta}_n$, the conditional choice probability that individuum *n* chooses choice sequence $y_n = \{y_{n1}, \dots, y_{nT}\}$ is given as follows:

$$Pr(y_n|\boldsymbol{\beta}_n) = \prod_{t=1}^{T} \frac{e^{\boldsymbol{\beta}_n{}'\boldsymbol{x}_{y_{nt}nt}}}{\sum_{i=1}^{I} e^{\boldsymbol{\beta}_n{}'\boldsymbol{x}_{int}}} \qquad (4)$$

Because $\boldsymbol{\beta}_n$ is not observable, the unconditional probability should be calculated by integration of (4) weighted by the population density distribution $f(\boldsymbol{\beta}_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma})$ of $\boldsymbol{\beta}_n$ (cf. equation (3)):

$$Pr(y_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma}) = \int Pr(y_n|\boldsymbol{\beta}_n) f(\boldsymbol{\beta}_n|\overline{\boldsymbol{\beta}}, \Delta, \gamma, \tau, \boldsymbol{\delta}, \boldsymbol{\Gamma})\, d\boldsymbol{\beta}_n \qquad (5)$$

To obtain individual level parameters for the willingness to pay calculation we follow the method described by TRAIN (2009). The willingness to pay (WTP) for the attributes are calculated on the basis of these obtained individual level utility parameters as the quotient of the attribute's utility parameter and the utility parameter of the attribute 'profit' as the price attribute.

## 5. Results

As the results of Table 4 show, the attribute 'profit' as well as the effect coded variables of the attribute 'partner acquaintance' and the variable 'partner's age 60years' were modelled as normally distributed random parameters. The statistical significance of the coefficients associated with the standard deviations of the random parameters indicates that they are significantly different from zero, and hence that the variables should indeed be modelled as random (HENSHER and GREENE, 2003: 145). This is an evidence for unobserved preference

**Table 4. Results of different models [a]**

| Variable | ML model | GMNL model | GMNL model with interactions |
|---|---|---|---|
| *Utility parameters:* | | | |
| ASC [b] | 0.27635 | 0.01719 | -0.03769 |
| Profit | 0.00008 ** | 0.00018 ** | 0.00017 ** |
| Partner's age 30years [c] | 0.15863 | 0.22254 | 0.17265 |
| Partner's age 30years [c] · farmer's age [d] | | | -0.00705 |
| Partner's age 45years | 0.07570 -- | 0.48380 - | 0.35084 - |
| Partner's age 60years [e] | -0.23433 | -0.70634 | -0.52349 |
| Partner's age 60years [e] · farmer's age [d] | | | 0.01404 |
| Partner acquaintance 1year [f] | -1.16189 ** | -2.60772 ** | -2.41514 ** |
| Partner acquaintance 5years | 0.28245 - | 0.54973 - | 0.51477 - |
| Partner acquaintance 10years [g] | 0.87944 ** | 2.05799 ** | 1.90037 ** |
| Partner arable [h] | 0.47181 ** | 1.11749 ** | 1.69302 ** |
| Partner arable [h] · farmer renewable [i] | | | 0.09302 |
| Partner arable · farmer arable | | | -0.41574 - |
| Partner arable [h] · farmer husbandry [k] | | | 0.32272 |
| Partner husbandry | -0.19071 - | -0.49971 - | -1.12596 - |
| Partner husbandry · farmer renewable | | | -3.32320 - |
| Partner husbandry · farmer arable | | | 0.36312 - |
| Partner husbandry · farmer husbandry | | | 2.96008 - |
| Partner biogas [l] | -0.28110 * | -0.61778 * | -0.56706 |
| Partner biogas [l] · farmer renewable [i] | | | 3.23018 |
| Partner biogas · farmer arable | | | 0.05262 - |
| Partner biogas [l] · farmer husbandry [k] | | | -3.28280 |
| *Standard deviation (SD) of the random parameters:* | | | |
| SD ASC [b] | 2.98792 ** | 3.50567 ** | 3.57337 ** |
| SD profit | 0.00006 ** | 0.00013 * | 0.00014 ** |
| SD partner's age 60years [e] | 0.73184 ** | 1.19586 * | 1.05106 ** |
| SD partner arable [h] | 0.58359 ** | 1.03161 * | 0.92109 ** |
| SD partner biogas [l] | 0.55028 ** | 1.09915 * | 1.19919 ** |
| *Structural parameters:* | | | |
| Tau | --- | 1.24774 ** | 1.10335 ** |
| Gamma | --- | -0.69725 | -0.33551 |
| *Model fit:* | | | |
| Number of participating farmers (N) | | 107 | |
| Observations (N · number of choice sets) | | 963 | |
| Log likelihood at zero | -899.89 | -726.30 | -708.09 |
| Simulated log likelihood at convergence | -733.70 | -717.43 | -706.39 |
| AIC (calculated on the basis of the number of observations) | 1,493.40 | 1,464.87 | 1,454.77 |

*Source:* Author's own calculations using the STATA command 'mixlogit' (HOLE, 2007) and 'gmnl' (GU et al., 2013).
*Notes:* + p <0.1; * p < 0.05; ** p < 0.01; *** p < 0.001.

[a] 10,000 Halton Draws; panel structure of the data was taken into account; indented variables depict the interaction terms; variables written in grey colour depict the level of the accompanying effect coded attributes which is omitted in the model calculation. Because the utility parameters will sum to zero over all levels of the effect coded variable, the utility parameter of the omitted level can be calculated as the negative sum of the utility parameters of the other levels. For the parameters written in grey colour, a statement about its significance is therefore not possible.

[b] Binary coded; reference: Status-quo alternative 'no CA'.

[c] Effect coded attribute variable that takes on the value 1 if the potential collaboration partner is 30 years old, (-1) if he/she is 45 years old and 0 if he/she is 60 years old.

[d] Age of the participating farmer is centred around the mean (38.38).

[e] Effect coded attribute variable that takes on the value 1 if the potential collaboration partner is 60 years old, (-1) if he/she is 45 years old and 0 if he/she is 30 years old.

[f] Effect coded attribute variable that takes on the value 1 if the potential collaboration partners know each other with positive acquaintance of 1 year, (-1) if they know each other with positive acquaintance of 5 years and 0 if they know each other with positive acquaintance of 10 years.

[g] Effect coded attribute variable that takes on the value 1 if the potential collaboration partners know each other with positive acquaintance of 10 years, (-1) if they know each other with positive acquaintance of 5 years and 0 if they know each other with positive acquaintance of 1 year.

[h] Effect coded attribute variable that takes on the value 1 if the potential collaboration partner runs a farm with the production activity 'arable farming', (-1) if he/she runs a farm with the production activity 'animal husbandry' and 0 if he/she runs a farm with the production activity 'biogas'.

[i] Effect coded individual specific variable that takes on the value 1 if the farmer runs a farm inter alia with the production activity 'animal husbandry', (-1) if the farmer runs a farm inter alia with the production activity 'arable farming' and 0 otherwise.

[k] Effect coded individual specific variable that takes on the value 1 if the farmer runs a farm inter alia with the production activity 'renewable energies', (-1) if the farmer runs a farm inter alia with the production activity 'arable farming' and 0 otherwise.

[l] Effect coded attribute variable that takes on the value 1 if the potential collaboration partner runs a farm with the production activity 'biogas', (-1) if he/she runs a farm with the production activity 'husbandry' and 0 if he/she runs a farm with the production activity 'arable farming'.

heterogeneity. In this respect, it should be noted that an additional GMNL model with the farmers individual risk attitude as interaction terms with the attributes was calculated. The results show that the preferences heterogeneity cannot be explained by the individual risk attitude of the farmer. Moreover, the structural parameter $\tau$ is significantly different from zero indicating substantial heterogeneity in individual scale. Therefore, using GMNL models is an appropriate approach, since unobserved heterogeneity in preferences and scale are both present. This is supported by means of the AIC-criterion which indicates that the calculated GMNL models fit the data better than the ML model (cf. Table 4). The WTP measures calculated on the basis of the GNML model with interactions are presented in Table 5.

*H1 (profit increase): The higher the expected increase in profits, the higher is a farmer's preference to establish a CA.*

The utility parameter of the attribute 'profit' is significantly positive in all calculated models (cf. Table 4). Thus, the farmers' willingness to establish a CA increases when the average expected increase in profit of the CAs first ten years gets higher. This result supports H1 that farmers’ preferences to establish CAs increases with increasing profits. Thus, H1 cannot be rejected.

*H2 (age): The closer the age of the potential collaboration partners, the higher is a farmer's preference to establish a CA.*

The utility parameter of the effect coded attribute variable 'partner age 30years' is only significant in the ML model (cf. ML model in Table 4: significantly positive utility parameter), whereas the utility parameter of the effect coded attribute variable 'partner age 60years' is significantly negative in all calculated models. The resulting utility parameter for the attribute variable 'partner age 45years' is positive in all calculated models.

In the GMNL model with interactions, the interaction term 'partner's age 30years · farmer's age' is significantly negative. This means that farmers who are older than 38 (which represents the age of the reference farmer) prefer a 45-year-old over a 30-year-old potential collaboration partner, whereas farmers who are younger than 38 prefer a 30-year-old over a 45-year-old partner. The interaction term 'partner's age 60years · farmer's age' is also significant in the GMNL model with interactions. This means that the reference farmer who is 38 prefers a 45-year-old over a 60-year-old partner. This preference increases with decreasing age of the farmer and decrease with increasing age of the farmer.

Looking at the respective WTP measures in Table 5, one can see that the WTP for a 30-year-old potential collaboration partner is not significantly different from zero (cf. Table 5). Furthermore, the average WTP for a 45-year-old partner is 2,840 €. The average compensation requirement for a 60-year-old partner is 3,504 €. Thus, the resulting marginal WTP for a partner who is 45 instead of 60 years old is 664 € (= 3,504 – 2,840).

In light of these results, H2 cannot be rejected that farmers' preferences to establish CAs increase the closer the age between the potential partners is.

**Table 5. WTP measures based on the GMNL model with interactions (in €)**

| WTP in € [a] | N | Mean | | SD | Confidence Interval | |
|---|---|---|---|---|---|---|
| Partner's age 30years | 107 | 664 | | 595 | -516 | 1,844 |
| Partner's age 45years | 107 | 2,840 | + | 1,592 | -316 | 5,997 |
| Partner's age 60years | 107 | -3,504 | * | 1,529 | -6,535 | -474 |
| Partner acquaintance 1year | 107 | -13,047 | * | 8,889 | -24,723 | -1,371 |
| Partner acquaintance 5years | 107 | 2,781 | * | 1,255 | 292 | 5,269 |
| Partner acquaintance 10years | 107 | 10,266 | * | 4,634 | 1,079 | 19,453 |
| Partner arable | 107 | 8,902 | + | 4,575 | -168 | 17,973 |
| Partner biogas | 107 | -3,370 | | 4,470 | -12,233 | 5,493 |
| Partner biogas if farmer renewable [b] | 40 | 20,500 | *** | 7,915 | 4,491 | 36,509 |
| Partner biogas if farmer husbandry [c] | 55 | -24,651 | *** | 3,007 | -30,679 | -18.622 |
| Partner husbandry | 107 | -5,532 | | 5,312 | -16063 | 4,999 |
| Partner husbandry if farmer renewable [b] | 40 | -36,757 | *** | 9,944 | -56,869 | -16,644 |
| Partner husbandry if farmer husbandry [c] | 55 | 12,057 | *** | 2,939 | 6,164 | 17,950 |

*Source:* Author's own calculations using the post-estimation command 'gmnlbeta' (Gu et al., 2013) for the GMNL model with interactions (cf. Table 4) in STATA 12.

*Notes:* $^{+}$ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

[a] We used a t-test to analyse whether the mean of the calculated WTP is statistically different from zero.

[b] The participating farmer runs a farm inter alia with the production activity 'renewable energies'.

[c] The participating farmer runs a farm inter alia with the production activity 'animal husbandry'.

*H3 (acquaintance): The more years of positive acquaintance between potential collaboration partners, the higher is a farmer's preference to establish a CA.*

The utility parameter of the effect coded attribute variable 'acquaintance 1year' is significantly negative in all calculated models (cf. Table 4). Therefore, a farmer will assign a negative utility to the case that he/she is acquainted with the potential collaboration partner for only one year. However, the utility parameter of the effect coded attribute variable 'acquaintance 10years' is significantly positive in all calculated models. As expected, the farmer's utility of establishing a CA is positive when the potential partners are acquainted for ten years. The resulting utility parameter for the effect coded attribute variable 'acquaintance 5years' is positive. The utility the farmer assigned to that case is therefore positive.

The farmers' average maximum willingness to pay for being acquainted with the potential collaboration partner for five (ten) years is 2,781 € (10,266 €). If the farmer is only acquainted with the potential collaboration partner for one year, he/she will on average have a maximum compensation requirement of 13,047 €. The farmers' marginal willingness to pay for being acquainted with the potential collaboration partner for five (ten) years instead of one (five) year(s) is 10,266 € (7,485 €).

In summary, H3 cannot be rejected that farmers' preferences to establish CAs increase, the more years of positive acquaintance between the potential partners exist.

*H4 (production activities): The more similar the production activities between potential collaboration partners are, the higher is a farmer's preference to establish a CA.*

In all calculated models (cf. Table 4), the utility parameter of the effect coded attribute variable 'partner arable' is significantly positive. Therefore, the utility farmers assign to a potential collaboration partner with the production activity 'arable farming' is positive. The GMNL model with interactions in Table 4 reveals that the utility parameters of the interaction terms with the attribute variable 'partner arable' are not significantly different from zero. Thus, there exists no difference in the utility animal husbandry-farmers and renewable energies-farmers assign towards a potential collaboration partner with the production activity 'arable farming'. Farmers' average maximum WTP for a CA with such a potential collaboration partner is 8,902 € (cf. Table 5).

The utility parameter of the effect coded attribute variable 'partner biogas' is significantly negative in all calculated models (cf. Table 4). The resulting utility parameter of the effect coded attribute variable 'partner husbandry' is also negative in all calculated models (cf. Table 4). Hence, the utility linked to a CA where the partner has the production activities 'arable farming and biogas' or 'arable farming and husbandry' is negative. The utility parameter of the interaction term 'partner biogas · farmer renewable' ('partner biogas · farmer husbandry') is significantly positive (negative) (cf. GMNL model with interactions in Table 4). The resulting utility parameter of the interaction term 'partner husbandry · farmer renewable' ('partner husbandry · farmer husbandry') is vice versa negative (positive). Thus, farmers with the production activity 'renewable energies' assign a positive utility to a CA with a partner that has the production activity 'biogas'. The same holds vice versa for farmers with the production activity 'animal husbandry'. They also assign a positive utility to a CA with a partner that has production activity is 'animal husbandry', too. As Table 5 depicts, farmers with the production activity 'renewable energies' have a maximum average WTP of 20,500 € for establishing a CA with a partner that has the production activity 'biogas'. However, they have a maximum compensation requirement of 36,757 € for establishing a CA with a partner that has the production activity 'animal husbandry'. In contrast, animal husbandry-farmers have a maximum average WTP of 12,057 € for a CA with a partner that the production activity 'animal husbandry', whereas they have a maximum compensation requirement of 24,651 € for a CA with a partner with the production activity 'biogas'.

In described results reveal that H4 cannot be rejected. Farmers who operate animal husbandry or renewable energies besides arable farming, are preferred more for establishing CAs by farmers who have the same production activities than by farmers who just operate arable farming.

## 6. Concluding remarks

Farm-level CAs are a possible strategy for agricultural entrepreneurs to handle escalating costs of equipment and labour that can often just be adopted in discrete amounts. Existing studies on farm-level CAs mainly focus on the respective economic advantages for their members as a result of accessing economies of scale. However, these analyses do not consider potential conflicts between the members of CAs, such as problems of timeliness, free-riding and opportunism. The risk of a future occurrence of these conflicts and the associated additional costs could be an important reason for farmers' reluctance to enter CAs in the first place in reality. Hence, the objective of this paper was to analyse farmers' preferences for CAs in an experimental setting. For this, a DCE was performed in which German farmers had to choose their preferred collaboration partner. Apart from the monetary advantage of establishing a CA with a potential partner, non-monetary attributes were considered, which could lead to the above-mentioned conflicts in the future of a partnership. The collected data was subsequently analysed by means of a GMNL model and average individual WTP measures were calculated to estimate the variation in each of the non-monetary attributes.

The results of the DCE reveal interesting insights into the drivers of farmers' decisions to establish CAs. Accordingly, it can be shown that a farmers' preference to establish a CA increases, as his age becomes closer to the age of the potential collaboration partner, which is in-line with existing survey results (e.g. HEIN et al., 2011). This indicates that a similar age can be seen as an indicator for “trust” and “like-mindedness” among potential collaboration partners. These latter aspects are suspected (although not investigated quantitatively) in many contributions to be important factors to mitigate future (costly) conflicts in CAs (e.g. ARTZ et al., 2010; HEIN et al., 2011; LARSÉN, 2007). Furthermore, the results of the present study confirm that a farmers' preference for CAs increase the more years of (positive) acquaintance between him and the potential partner exist. Therefore, knowing the potential partner for a longer time can also be seen as an indicator for “trust” and “like-mindedness”, which increases the preparedness to establish a CA. Finally, the outcome of the DCE suggests that the production activities also play an important role in the occurrence of CAs. Accordingly, the preferences of farmers to establish a mutual collaboration increase when the production activities of the two potential partners are similar, for instance if both practice animal husbandry besides arable farming. Besides economic considerations, this could be also traced back to non-monetary motives like traditional thinking (e.g. BENZ, 2006).

The findings of this study are of practical importance for farmers as well as for agricultural consultants and politicians. On the basis of the results, farmers are able to make decisions regarding the establishment of CAs in a more structured and objectified way due to an improved understanding of their respective motives and obstacles. In this respect, the calculated WTP measures for the non-monetary attributes like 'age of the collaboration partner' could particularly help to improve comparability between monetary and non-monetary attributes and thus facilitate the establishment of farm-level CAs in the future. Likewise, agricultural consultants receive useful information for improved specific advices to farmers about whether or not a CA is suitable, and if so, which CA is an appropriate strategy for the farm in the future. Moreover, agricultural politicians could include the results into the design of potential measures for supporting farm-level CAs in countries, where a high potential for increasing the efficiency of primary agricultural production by means of such arrangements exist.

However, the results of the study should be interpreted with caution due to some limitations of the data gained in the DCE. First, the results are based on hypothetical decisions like in all other studies that apply laboratory experiments. The question if the decision-making behaviour of real decision situations is different of those in hypothetical decision situations has been examined several times. The respective results provide abundant evidence that there is little discrepancy between real and hypothetical decision-making behaviour (e.g. KUEHBERGER et al., 2002). Nevertheless, this should be confirmed by comparable studies in the agricultural context. Second, the transferability of the findings, for example to other countries, should be tested in additional DCEs. Lastly, in the DCE no statements are made about the degree and the specific legal form of a CA for complexity reasons.

## References

ALLEN, D.W. and D. LUECK (1998): The Nature of the Farm. In: The Journal of Law & Economics XLI: 343-386.

ANDERSSON, H., K. LARSÉN, C.J. LAGERKVIST, C. ANDERSSON, F. BLAD, J. SAMUELSSON and P. SKARGREN (2005): Farm cooperation to improve sustainability. In: AMBIO: A Journal of the Human Environment 34(4): 383-387.

ARTZ, G. (2014): Equipment sharing in agriculture. In: Encycolpedia of Food and Agricultural Ethics: 1-7. Springer Science+Business Media Dordrecht. DOI: 10.1007/978-94-007-6167-4_66-4.

ARTZ, G., G. COLSON and R. GINDER (2010): A Return of the Threshing Ring? A Case Study of Machinery and Labor-Sharing in Midwestern Farms. In: Journal of Agricultural & Applied Economics 42(4): 805-819.

AURBACHER, J., C. LIPPERT and S. DABBERT (2011): Imperfect markets for used machinery, asynchronous replacement times, and heterogeneity in cost as path-dependent barriers to cooperation between farmers. In: Biosystems Engineering 108(2): 144-153.

BENZ, M. (2006): Entrepreneurship as a Non-profit-seeking Activity. In: International Entrepreneurship and Management Journal 5: 23-44.

BREUSTEDT, G., J. MÜLLER-SCHEEẞEL, J. and U. LATACZ-LOHMANN (2008): Forecasting the adoption of GM oilseed rape: Evidence from a discrete choice experiment in Germany. In: Journal of Agricultural Economics 59(2): 237-256.

CRAIG, S. and J. SUMBERG (1997): Machinery rings in UK agriculture: an example of opportunistic cooperation. In: Journal of Rural Cooperation 25: 3-20.

DEININGER, K. and D. BYERLEE (2012): The rise of large farms in land abundant countries: Do they have a future? In: World Development 40(4): 701-714.

DOLUSCHITZ, R. (2001): Kooperationen in der Landwirtschaft. In: Berichte über Landwirtschaft 79: 375-398.

DOHMEN, T., A. FALK, D. HUFFMAN, U. SUNDE, J. SCHUPP and G.G. WAGNER (2011): Individual risk attitudes: measurement, determinants, and behavioral consequences. In: Journal of the European Economic Association 3: 522-550.

ESPINOSA-GODED, M., J. BARREIRO-HURLÉ, J. and E. RUTO (2010): What do farmers want from Agri-environmental scheme design? A choice experiment approach. In: Journal of Agricultural Economics 61(2): 259-273.

FIEBIG D.G., M.P. KEANE, J.J. LOUVIERE and N. WASI (2010): The generalized multinomial logit model: Accounting for scale and coefficient heterogeneity. In: Marketing Science 29: 393- 421.

GU, Y., A.R. HOLE and S. KNOX (2013): Fitting the generalized multinomial logit model in Stata. In: The Stata Journal 13: 382 397.

HARRIS, A. and M. FULTON (2000): The CUMA Farm Marchinery Co-operatives. Center for the Study of Co-operatives. University of Saskatchewan.

HEIN, K., P. LAVÈN and R. DOLUSCHITZ (2011): Voraussetzungen, Vorteile und Probleme in Kooperationen zwischen landwirtschaftlichen Unternehmen—theoretische Analyse und empirische Überprüfung. In: Berichte über Landwirtschaft 89(1): 13-37.

HENSHER, D.A. and W.H. GREENE (2003): The mixed logit model: the state of practice. Transportation, 30(2): 133-176.

HOLDERNESS, C.G. (2003): Joint ownership and alienability. In: International Review of Law and Economics 23(1): 75-100.

HOLE, A.R. (2007): Estimating mixed logit models using maximum simulated likelihood. The Stata Journal 7: 388-401.

JOHNSON, N. and V. RUTTAN (1994): Why are farms so Small? In: World Development 22: 691-706.

KEANE, M. (2006): The generalized logit model: preliminary ideas on a research program, presentation at Motorola-CenSoC Hong Kong Meeting, 22 October, 2006.

KUEHBERGER, A., M. SCHULTE-MECKLENBECK and J. PERNER (2002): Framing decisions: Hypothetical and real. In: Organizational Behavior and Human Decision Processes 89(2): 1162-1175.

KUHFELD, W.F. (2010): Marketing research methods in SAS. Experimental design, choice, conjoint, and graphical techniques. Cary, NC: SAS Institute, Inc.

LAGERKVIST, C.J. and H. HANSSON (2012): Machinery-sharing in the presence of strategic uncertainty: evidence from Sweden. In: Agricultural Economics 43(1): 113-123.

LARSÉN, K. (2007): Participation, incentives and social norms in partnership arrangements among farms in Sweden. Selected paper at the American Agricultural Economics Association Annual Meeting. Portland, OR, 29th July-1st August 2007.

LARSÉN, K. (2010): Effects of machinery-sharing arrangements on farm efficiency: evidence from Sweden. In: Agricultural Economics 41(5): 497-506.

LOUVIERE, J. D., D.A. HENSHER and J.D. SWAIT (2010): Stated choice methods - analysis and applications. University Press, Cambridge.

MCBRIDE, W.D. (2003): Production costs critical to farming decisions. In: Amber Waves 1(4): 38-45.

MCFADDEN, D. (1974): Conditional logit analysis of qualitative behaviour. In: ZAREMBKA, P. (Hrsg.): Frontiers in econometrics. Academic Press, New York: 105-142.

NASS (2015): Farm Production Expenses Annual Summary. Internet site: http://usda.mannlib.cornell.edu/MannUSDA/viewDocumentInfo.do?documentID=1066. Accessed 25 January, 2015.

NIELSEN, V. (1999): The effect of collaboration between cattle farms on the labour requirement and machinery costs. In: Journal of Agricultural Engineering Research 72(2): 197-203.

SAOS (2008): Co-operative Rural Business Rings Socio Economic Impact Study. Ingliston, Scotland: SAOS, Ltd., March 2008.

DE TORO, A. and P.A. HANSSON (2004): Machinery Cooperatives – a case study in Sweden. In: Biosystems Engeneering 87: 13-25.

TRAIN, K. (2009): Discrete Choice Methods with Simulation. University Press, Cambridge.

TRAIN, K. and M. WEEKS (2005): Discrete choice models in preference space and willingness-to-pay space. Springer Netherlands, 2005.

VALENTINOV, V. (2007): Why are cooperatives important in agriculture? An organizational economics perspective. In: Journal of Institutional Economics 3(01): 55-69.

VARIAN, H.R. (1992): Microeconomic analysis. 3rd Edition. New York: Norton.

WOLFLEY, J.L., J.W. MJELDE, D.A. KLINEFELTER and V. SALIN (2011): Machinery-Sharing Contractual Issues and Impacts on Cash Flows of Agribusinesses. In: Journal of Agricultural and Resource Economics 36(1): 139-159.