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Do farmers act like perfectly rational profit maximisers? Results of an extra-laboratory experiment

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ABSTRACT

Many economic studies are based on the theory of the *homo oeconomicus*, frequently put simply and described as a perfectly rational, profit-maximising decision-maker. However, there are often considerable differences between the theoretical decisions based on this theory and the behaviour of farmers observed in reality. The specific magnitude and the influencing factors of this discrepancy are hardly analysed due to the lack of a benchmark in reality. Therefore, on the basis of realistic decisions made by farmers in an extra laboratory experiment, the present study investigates if farmers act as perfectly rational profit maximisers. Furthermore, factors shall be identified that influence deviations from relative economic performance. The results show that farmers are not perfectly rational profit-maximising decision-makers. The decision-making behaviour is rather influenced by the farmers' socio-demographic and socio-economic characteristics, such as the gender or the leading position of the farmer.

KEYWORDS: multiple goal decision making; bounded rationality; business simulation games; experimental economics

1. Introduction

Most studies, models, and forecasts dealing with the economic management of agricultural businesses are based on the underlying assumption of the *homo oeconomicus* (Camerer and Fehr, 2006; Fehr and Gächter, 2001; Gintis, 2000). Often the *homo oeconomicus* is simplified as an actor who maximises the profit as a proxy for the utility in a perfectly rational way. Hence, the actors are often assumed as perfectly rational profit maximisers (Camerer and Fehr, 2006; Happe *et al.*, 2007; Roth *et al.*, 1991). If, however, the theoretically expected behaviour is compared with the real decisions of entrepreneurs, it becomes clear that a considerable discrepancy exists (Camerer, 2001; Camerer and Fehr, 2006; Fehr and Gächter, 2001; Gintis, 2000; Roth *et al.*, 1991). This also becomes apparent regarding the central question about the corporate success. Hence, decision-makers in general and farmers in particular reach less profit than what would be possible using theoretically optimal decision behaviour assuming perfectly rational profit maximising (Nuthall, 2009). Frequently mentioned explanatory approaches for the discrepancy are the existence of multiple objectives (Benz, 2009) and bounded rationality (Kahneman, 2002; Selten, 1990; Simon, 1956).

However, the magnitude of the discrepancy between theoretically expected behaviour and real decisions, as well as which factors influence the magnitude, still remain unknown. With this in mind, the present study aims to investigate if farmers act as perfectly rational profit maximisers and if not, which factors significantly influence a deviation. Answering these questions is especially relevant for advising individual enterprises as well as for policy impact analysis. The analysis of the influence of individual characteristics on deviations from profit-maximizing behaviour can be used to improve the results of farm modelling approaches and, therefore, forecasts of farm developments.

In order to do so, it is difficult to use real operating data because in reality the individual benchmark for each farm cannot be clearly derived (Pasour, 1981). Therefore, an experimental approach is necessary to control the framework conditions. Two methods seem to be particularly suitable: laboratory experiments and business simulation games. In contrast to laboratory experiments, business simulation games allow a realistic design and setting of the decision situations that is an important advantage (Levitt and List, 2007). In our business simulation game farmers lead a virtual farm and are asked to make decisions about the production programmes in consecutive production periods. These production programmes will then be analysed with regard to their relative economic performance, meaning the ratio between the achieved expected profit and the theoretically possible expected profit assuming perfectly rational profit maximising.

To our knowledge, we are the first who analyse the specific magnitude and the influencing factors of the

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discrepancy between theoretically expected behaviour assuming perfectly rational profit maximising and real decisions using a business simulation game applied to German farmers. Furthermore, many scientists work on studies about bounded rational behaviour (Selten, 1990, Simon, 1959). This study, however, focuses on different explanatory approaches that have not been examined as extensively. We analyse the influence of individual characteristics in order to improve the results of theoretic modelling. Also forecasts can be improved with knowledge about factors influencing deviations from profit-maximising behaviour.

The present study is structured as follows: In section 2, hypotheses are derived from the literature. In section 3, the design of the business simulation game will be described and will then lead over to methodology selection (section 4). The sample description in section 5 will be followed by the presentation of results and discussion (section 6) before the study will end with conclusions and future research prospects (section 7).

2. Hypotheses

Many studies have focused on the decision-making behaviour of entrepreneurs (Fehr and Gächter, 2001; Gintis, 2000). It is described that there often exist considerable discrepancies between the theoretically expected actions of profit-maximising actors and the decisions of real persons (Camerer and Fehr, 2006; Fehr and Gächter, 2001; Gintis, 2000; Nuthall, 2009; Roth *et al.*, 1991). Many of these deviations from the theoretic economic optimum are explained by Simon (1956) as consequences of bounded rational behaviour what often can be observed in practice (Selten, 1990). Furthermore, decision-makers rely on judgmental heuristics (Tversky and Kahneman, 1974). We examine whether differences can be observed between the theory of pure profit maximisation and experimentally observed decisions of the farmers. Our hypothesis is:

H1: Farmers do not act as perfectly rational profit maximisers.

Benz (2009) found that decision-makers often pursue several objectives, such as generating profit, striving for security, tradition, leisure activities, or social acknowledgment. The theory of the perfectly rational profit maximiser ignores all of these multiple objectives. Agriculture is especially confronted with risk. For example, volumetric risks caused by weather fluctuations and diseases are an important issue. Therefore, risk reduction may be an entrepreneurial objective of major importance (Hardaker *et al.*, 1997). It can be assumed that risk reduction is a utility-providing factor that competes with the profit-maximising intention of the farmers. With this background, we formulate the following hypothesis:

H2: Farmers choose production programmes with reduced income risk and accept less expected income than what would be possible.

Besides bounded rationality and risk reduction, further socio-demographic and socio-economic characteristics of farmers might influence the relative economic performance. Even the bounded rationality described by Simon (1956) and the judgemental heuristics revealed by Tversky and Kahneman (1974) are based on the individual-specific characteristics of the decision-makers. These are often latent variables which cannot be measured directly and objectively. Therefore, they can only be included in a (mathematical) model by using indicator variables (Hausman and Taylor, 1981). The collected socio-demographic and socio-economic parameters of the farmers illustrate their living conditions and thus are suitable to describe the subject-specific latent variables. Hence, investigating the extent of the socio-demographic and socio-economic characteristics of farmers may explain the degree of relative economic performance. This leads to our final hypothesis:

H3: Differences in the relative economic performance can be explained by socio-demographic and socio-economic characteristics.

3. Study Design

The experiment is divided into three sections. In the first section, a multi-period one-person business simulation game is carried out. Subsequently, a Holt-and-Laury lottery (HLL) (Holt and Laury, 2002) is performed to investigate the participants' risk attitude. In the third section of the experiment, socio-demographic and socio-economic information about the participants is collected. The computer based experiment is carried out with farmers who know that they are participating in an experiment and that their decision-making behaviour is documented and analysed. Furthermore, the experiment was conducted on an agricultural trade fair and not in a laboratory setting. Hence, the business simulation game can be classified as an 'extra-laboratory experiment' according to Charness *et al.* (2013).

Design of the business simulation game

In the first section of the experiment - the business simulation game - participants are asked to manage a virtual 100-hectare arable farm over six production periods. Each production period depicts one year of farming and equals to one round of the business simulation game. At the beginning of the experiment, the participants are introduced to the farming situation. Each participant receives an initial capital of play money €100,000[3]. In each production period, living costs in the amount of €30,000 play money are deducted. After each completed period, every participant receives a premium of €300 per hectare. The periods in the game build on one another and, at the beginning of each period, the participants are informed about the results of the previous one. A production period is completed as soon as the participant has made the following decisions:

1. Production programme decision: Design of the production programme for using the total farmland available to cultivate wheat, silage maize, sorghum, and flowering cover crops.
2. Contract decision: Conclusion of a substrate supply contract of 0 t, 1,500 t, 3,000 t, or 4,500 t of fresh mass for a neighbouring biogas plant. For fulfilling the obligation to deliver, silage maize, sorghum, and flowering cover crops are under deliberation.

[3] In mid-September, €1 was approximately equivalent to £0.80 and $US1.29 (www.xe.com)

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For the production programme decision, further rules are given. One crop rotation includes at least two crops. This restriction is implemented by setting a minimum requirement of 5 ha of cultivation for wheat and silage maize. For all production methods, a maximum cultivation extent of 70 hectares of farmland can be used. All cultivation extents have to be integers, apart from this limitation, no specific field sizes were given. The completed substrate quantity delivered is paid with €35 per ton independently of whether the fresh weight consists of silage maize, sorghum, or flowering cover crops.

However, the decisions are additionally affected by various stochastic parameters which make the decision situation more realistic (Harrison and List, 2004). Hence, the yields as well as the prices are depicted as uncertain factors in the business simulation game. They change randomly from period to period and, thus, vary between the participants. Starting from an initial value that is equal for all farmers in the game, the market prices follow an arithmetic Brownian motion (Dixit and Pindyck, 1994:59) as shown in Figure 1.

The occurring market prices fall or rise in each period by €20 per ton for wheat and €1.50 per ton for silage maize with a probability of 50% starting from the price in the previous period (Figure 1). Also, the weather conditions influence the gross margins of the production alternatives. We distinguish between above-average, average and below-average weather conditions expecting above-average and below-average weather with a probability of 20% each and average weather with a probability of 60%. Above-average weather means that the yields per hectare of all crops reach their maximum, whereas, for below-average weather, the yields fall to a minimum as described in Table 1. The three weather conditions with their probabilities of occurrence as well as the corresponding yields per hectare are announced in each round.

Despite the uncertain yields per hectare, the chosen supply contract must be fulfilled by 100%. If this is not possible on the basis of the own harvest, the lacking amount of substrate must be purchased on the market for the double of the current market price of silage maize. If the harvest of biomass exceeds the contract, the surplus is sold for the market price of silage maize.

As there are not any storage facilities available for the crops harvested, all goods are sold for the current prices at the end of each period. The prices and the occurred weather conditions of the previous period are announced at the beginning of each new production period. Furthermore, participants receive additional information about the profit achieved as well as the cultivation and contract decisions of the previous periods. The earned assets sum up until the end of the game.

Holt-and-Laury lottery

After the business simulation game, the second part of the experiment focuses on the participants' risk attitude using a Holt-and-Laury lottery (HLL) (Holt and Laury, 2002). This procedure is already established in agricultural economics (Brick *et al*., 2012) and, therefore, is not explained in more detail here. Participants have to decide between the lotteries A and B. In lottery A, it is possible to win either €200 or €160 and €385 or €10 in the more risky lottery B. The probabilities to win one of the two aforementioned possible lottery outcomes are systematically varied in steps of 10% resulting in ten different decision-making situations. The change of the decision for lottery A to the more risky lottery B provides the HLL-value and reflects the participants' risk attitude. HLL-values (number of safe choices) from 1 to 3 indicate a risk-seeking behaviour, an HLL-value of 4 means that the participant is risk neutral and HLL-values from 5 to 10 denote risk-averse participants. The amounts of money used in the HLL are comparable to the possible prize money that can be won by the participants.

Expense allowance and incentive compatibility

In order to attract farmers to participate in the experiment, an expense allowance in the amount of €10 per participant is paid. With a planned duration of the game of 30 minutes, the expense allowance corresponds to an hourly wage of €20, while the average hourly wage in the German agricultural sector is €9.92 (DESTATIS, 2010). This should cover the opportunity costs of participants.

For ensuring incentive compatibility, additional monetary incentives are set for 'good' decisions. The

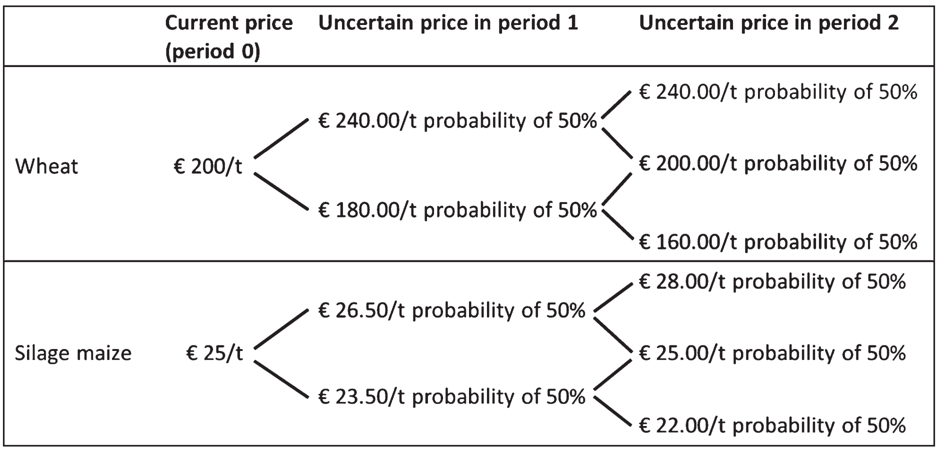

Figure 1: Potential price developments for the first two production periods for wheat and silage maize

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Table 1: Possible production alternatives to cultivate the farmland

	Wheat	Silage maize	Sorghum	Flowering cover crops	
Marketing option (market price)	Spot market (volatile price)	Substrate input for Biogas plant (€35/t) Spot market (volatile price)	Substrate input for Biogas plant (€35/t)	Substrate input for Biogas plant (€35/t)	Nature conservation (€640/ha)
Costs of cultivation	€ 970/ha	€ 832/ha	€ 800/ha	€ 880/ha	€ 340/ha
Minimum extent	5 ha	5 ha	0 ha	0 ha	
Maximum extent	70 ha	70 ha	70 ha	70 ha	
Yield for					
above-average weather (20%)	9.6 t/ha	60.5 t/ha	53.5 t/ha	46.0 t/ha	No yield measured, biodiversity
average weather (60%)	8.0 t/ha	55.0 t/ha	48.0 t/ha	40.0 t/ha	
below average weather (20%)	6.4 t/ha	49.5 t/ha	42.5 t/ha	34.0 t/ha	

experiment is planned for 120 participants, with tolerance of 5%. In total €2,005 of prize money is offered, so that the expected prize per participant is €16.71. As the length of the game of 30 minutes is already compensated by an expense allowance of €10, the chance to win additional prize money should motivate the participants to make well-considered decisions.

Previous studies revealed that incentives influence the behaviour of participants in experiments. They are considering their decisions longer and more intense if the amount of incentives depends on their own decisions (Camerer and Hogarth, 1999; Duersch *et al*., 2009). Furthermore, Camerer and Hogarth (1999) point out that participants overestimate the probability of being selected if only few participants receive an incentive. Due to this reason, we decided to pay a higher incentive to only few participants. Out of the planned 120 participants of the business simulation game, four farmers will be randomly selected for a cash prize. The amount of each cash prize for the first three winners depends on the success in the business simulation game. They receive the share of €540 that corresponds to their relative economic performance. For the fourth cash prize, one participant is randomly selected for whom the Holt and Laury lottery is carried out. The participant receives between €10 and €385 according to his/her risk attitude.

4. Deviation of the Benchmark and Data Analysis

Assuming a pure profit-maximising decision-maker, an optimal production programme provides the maximum expected gross margin for one period of the business simulation game. Due to assuming a stochastic process for the market price developments, changes of the prices deliver new information for the expected prices of the following periods (Figure 1). Therefore, for each period and each participant an individual optimal production programme has to be calculated. Hence, for the analysis, all optimal production programmes are calculated applying the procedure described in Table 2.

The calculation of the profit-maximising production programme applies full enumeration, i.e. all possible proportions of the production activities and all contract decisions are systematically combined (Table 2). For each of the 5.8 billon possible combinations the expected total gross margin is calculated. Finally, the production programme with the highest expected total gross margin represents the optimal solution for this production period.

Furthermore, the expected total gross margins of the production programmes chosen by the participants are calculated (Table 2, first column). The quotient of the realized and the maximum expected total gross margin of each period of the business simulation game and each participant describes the relative economic performance of the decisions made by the participants. The lower this value is the more the farmer's decision differs from the decision of a perfectly rational profit maximiser.

In order to answer our hypotheses, we have to analyse the relative economic performance. It must be noted that the data generated by the business simulation game cannot be considered as independent as it includes several observations of each individual (relative economic performance for each farmer in each of the six production periods). Thus, the data structure can be described as a panel. That has to be taken into account when analysing the data as otherwise the statistic methods do not provide efficient and consistent results (Hausman and Taylor, 1981). The main focus of the following investigations is on the inter-subjective differences between the farmers. In order to efficiently depict the latter in a regression model, we apply a Between Regression on the mean of the relative economic performance:

$$\bar{y}_i = a + \bar{x}_i^l \cdot \boldsymbol{\beta}_i + z_i^l \cdot \gamma_i + u_i \tag{1}$$

The individual time variant variable (here: mean of relative economic performance of individual i during the six production periods) is expressed by $\bar{y}_i$. Parameter a is a constant. $\boldsymbol{\beta}_i$ indicates the estimated coefficients for the independent variables which are time variant. In this case, the mean of the independent variable ($\bar{x}_i^l$) has to be fit in. γ_i indicates the estimated coefficients for the independent variables which are time constant. They can be directly included (z_i^l) in the regression. u_i forms the error term. The results of the Between Regression can be interpreted more intuitively than the results of a Random Effects Regression, which would provide identical values for the estimators (Hausman and Taylor, 1981).

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Table 2: Calculation of the profit-maximizing production programs and the relative economic performance of each participant in each period

Observed decisions of the participant in the experiment	Derivation of the benchmark for a profit-maximizing decision-maker
Chosen production program:	About 5.8 bn. possible production programs:
Chosen amount of wheat	5, 6, …, or 70 ha wheat
Chosen amount of silage maize	5, 6, …, or 70 ha silage maize
Chosen amount of sorghum	0, 1, …, or 70 ha sorghum
Chosen amount of flowering cover crops used as biogas substrate	0, 1, …, or 70 ha flowering cover crops used as biogas substrate
Chosen amount of flowering cover crops for nature conservation	0, 1, …, or 70 ha flowering cover crops for nature conservation
Contract decision:	Four possible contract decisions:
Chosen supply contract	Supply contracts: 0 t; 1,500 t; 3,000 t; 4,500 t
Calculation of expected total gross margin for the chosen production program:	Calculation of expected total gross margin for the optimized production program:
Calculation of the 12 potential total gross margins[(a)]	Calculation of the 12 potential total gross margins[(a)] for each theoretically feasible production program
Weighted mean of 12 possible outcomes	Weighted mean of 12 possible outcomes for each of the production programs is calculated
	Production program with highest expected total gross margin is the benchmark
Relative economic performance=$\frac{\text{Achieved expected total gross margin}}{\text{Highest expected total gross margin}}$	

Note:
(a)3 weather conditions · 2 price developments of silage maize · 2 price developments of wheat.

5. Sample Characteristics

The data set used was collected with an experiment carried out at the trade fair 'EuroTier' that took place in Hanover, Germany, from November 13–16, 2012. For the experiment, 946 visitors of the trade exhibition were directly asked to participate. In total, 123 farmers participated. The first section of the experiment, the business simulation game, took 23.1 min, whereby 11.2 min were used to read the instructions, and processing the business simulation game took 11.8 min. Another 2.9 min were used for the second section, the HLL, and 4.3 min for the questionnaire in the last section of the experiment. On average, the participants needed 30.2 min to complete the experiment. Table 3 displays some socio-demographic and socio-economic characteristics of the participating farmers.

When the experiment was carried out, participants were on average 29 years old, including the youngest participant with 16 years and the oldest in the age of 62 years. The farmland used in real business by each farmer has an average size of 245 ha. The participants assess the performance of their farm to be slightly higher than average. The average HLL-value of 4.4 indicates that the participants are risk neutral. Concerning the HLL, it is striking that 37 participants (30%) change more than once between lottery A and B. From a theoretical perspective, there is no reason to switch between the two lotteries offered several times (Holt and Laury, 2002). Approximately 30% of the participants are managers of a farm, while 40% consider themselves as farm successors. In total, 63% of the participants have completed an agricultural training, while 51% hold a university degree, and 41% of them even studied agricultural sciences. All in all, 37% of the participants focused on economics during their studies. In addition, about half of the participants indicate that they have already applied extensive farming methods when it was not economically advantageous due to environmental protection aspects. Moreover, 63% consider the cultivation of flowering cover crops as useful due to environmental protection reasons, whereas only 31% would support it even from an economic perspective.

As we look at six production periods of 123 virtual farms in the business simulation game, the sample size will comprise 738 observed production programme decisions. Table 4 gives an overview of the chosen production programmes of the farmers.

6. Results and Discussion

Hypothesis 1 assumes that farmers are perfectly rational profit maximisers. If this is the case, farmers decide for the production programmes with the highest expected profit and reach a relative economic performance of 100%. When comparing the theoretically possible expected gross margins with the expectation values of the decisions made by farmers in the business simulation game, however, differences in the relative economic performance become apparent. Figure 2 depicts the average of the relative economic performance of farmers over the six periods observed.

In the conducted business simulation game, no farmer made always perfectly profit-maximising decisions. Nevertheless, 28.5% of the farmers reached a relative economic performance higher than 90%, whereby only 8.9% of the participants reached less than 70%. A normal distribution for the relative economic performance depicted in Figure 2 cannot be rejected according to a Kolmogorov-Smirnov test (p-value=0.783). Furthermore, a single sided t-test for independent samples confirms that the mean of the reached relative economic performance of 83.7% differs significantly from the maximum (p-value<0.001). This can be interpreted as a first

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Table 3: Socio-demographic and socio-economic characteristics of the participants (N=123 farmers)

Characteristic	Mean	Standard deviation
Age (in years)	29.2	10.9
Share of female participants	12.2%	-
Years of education	13.4	2.6
Agricultural training [(a)]	62.6%	-
Economic study focus [(b)]	36.6%	-
Manager/successor [(c)]	69.9%	-
HLL-value [(d)]	4.4	2.6
Consistency of lottery decisions [(e)]	69.9%	-
Evaluation of supply contracts [(f)]	2.9	1.0
Evaluation of agri-environmental measures [(g)]	2.7	0.9
Subjective estimation of farm success [(h)]	57.2	25.4
Farm is main source of income	86.2%	-
Farmland in ha	245.0	440.2
Share of arable farms [(i)]	30.9%	-
Time needed to complete the business simulation game (in minutes)	30.2	22.4

Notes:
(a) 1=completed an agricultural training; 0=no completed agricultural training.
(b) 1=economic study focus; 0=other study focus or no study degree.
(c) 1=farm manager or farm successor; 0=other position.
(d) 1–3=risk seeking; 4=risk neutral; 5–9=risk averse.
(e) 1=without multiple switches between the lotteries in the Holt-and-Laury lottery; 0=with multiple switches between the lotteries.
(f) What is your opinion about the conclusion of supply contracts? 1=completely against to 5=completely in favour.
(g) What is your opinion about agri-environmental measures? 1=completely against to 5=completely in favour.
(h) How do you evaluate your farm success in comparison to other farms? 0=very under-average to 100=very above-average.
(i) 1=arable farm; 0=processing/forage/others.

indication that farmers' decisions are based on approximations instead of exact calculations.

Hypothesis H1, stating that farmers do not act as perfectly rational profit maximisers, cannot be rejected. The majority of the farmers make decisions that differ significantly from those of a perfectly profit-maximising decision-maker.

It needs to be tested whether farmers differ systematically from profit maximisation. If random effects are the reason for the observed non-optimal behaviour, the deviations from the profit-maximising areas of cultivation are normally distributed and no underlying decision-making pattern can be identified. However, if these deviations cannot be considered as random, it must be investigated which factors that have not yet been considered that may be the reason for the differences. Figure 3 shows the deviations of the amounts of different production activities from the amounts in the profit-maximising cultivation programmes.

In each period, the profit-maximum cultivation area for each production activity is subtracted from the cultivation area selected by the farmers. Compared to profit-maximising decision-makers, farmers decide to cultivate on average 19.2 ha too much wheat and 8.7 ha too many flowering cover crops. Although the cultivation of flowering cover crops was economically not optimal in any period of the business simulation game, it was realized in 51% of all periods. The production areas for silage maize and sorghum are 23.3 ha and 4.7 ha too small to attain the maximal expected total gross margins. While a too large-scale contract was chosen in 2.7% of all periods, farmers decided for too small-scale supply contracts in 69.4% of all periods. The described differences from an economically optimal solution are highly significant for each production activity and for the contract size (p-value<0.01). This provides evidence that systematic deviations in the cultivation programmes are the reason for the diminished relative economic performance. Thus, further factors, which farmers consider for their decisions that therefore deviate from the profit-maximising behaviour, need to be identified.

A possible factor that makes the farmers deviate from the aim of profit-maximising might be the reduction of profit risk. In order to reduce the profit risk, a lower average relative economic performance could be accepted. In a first step, we investigate how the selection of the production programme influences the standard deviation of the possible results of a period. On average, however, the standard deviation of the profits calculated from the production programmes chosen by the farmers is higher than that of the profit-maximising production

Table 4: Overview of production programmes chosen by the participants (N=738 production programme decisions)

Characteristic	Mean	Standard deviation
Amount of wheat in ha	33.8	20.2
Amount of silage maize in ha	44.7	20.0
Amount of sorghum in ha	12.7	15.6
Amount of flowering cover crops for use in Biogas plant in ha	4.4	8.0
Amount of flowering cover crops for ecological purposes in ha	4.4	8.8
Contracted amount of biomass in tonnes	2,774.4	1,310.2

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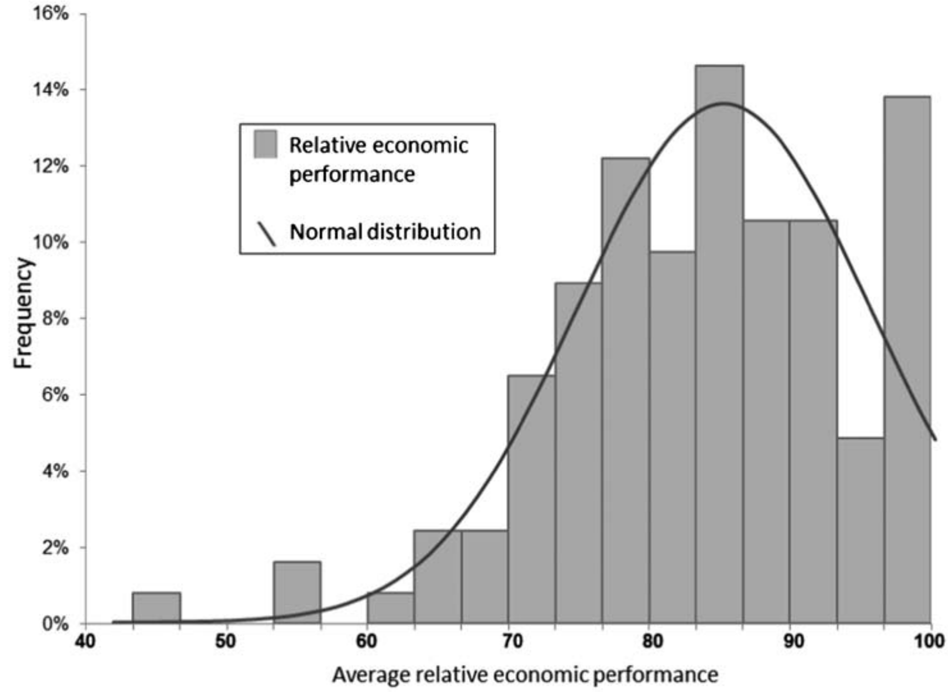

Figure 2: Average relative economic performance of farmers over six production periods (N=123 farmers)

programmes. Thus, the possible entrepreneurial objective of risk reduction is not reached by the participants.

In a second step, we analyse the impact of the risk attitude (HLL-value) on the relative economic performance using a between regression. Besides the HLL-value, other subject-specific characteristics are included in the regression model. The results are depicted in Table 5.

The Between Regression shows that the risk attitude, expressed in the HLL-value has no significant influence on the relative economic performance of a participant. Consequently, the aim of risk reduction cannot be

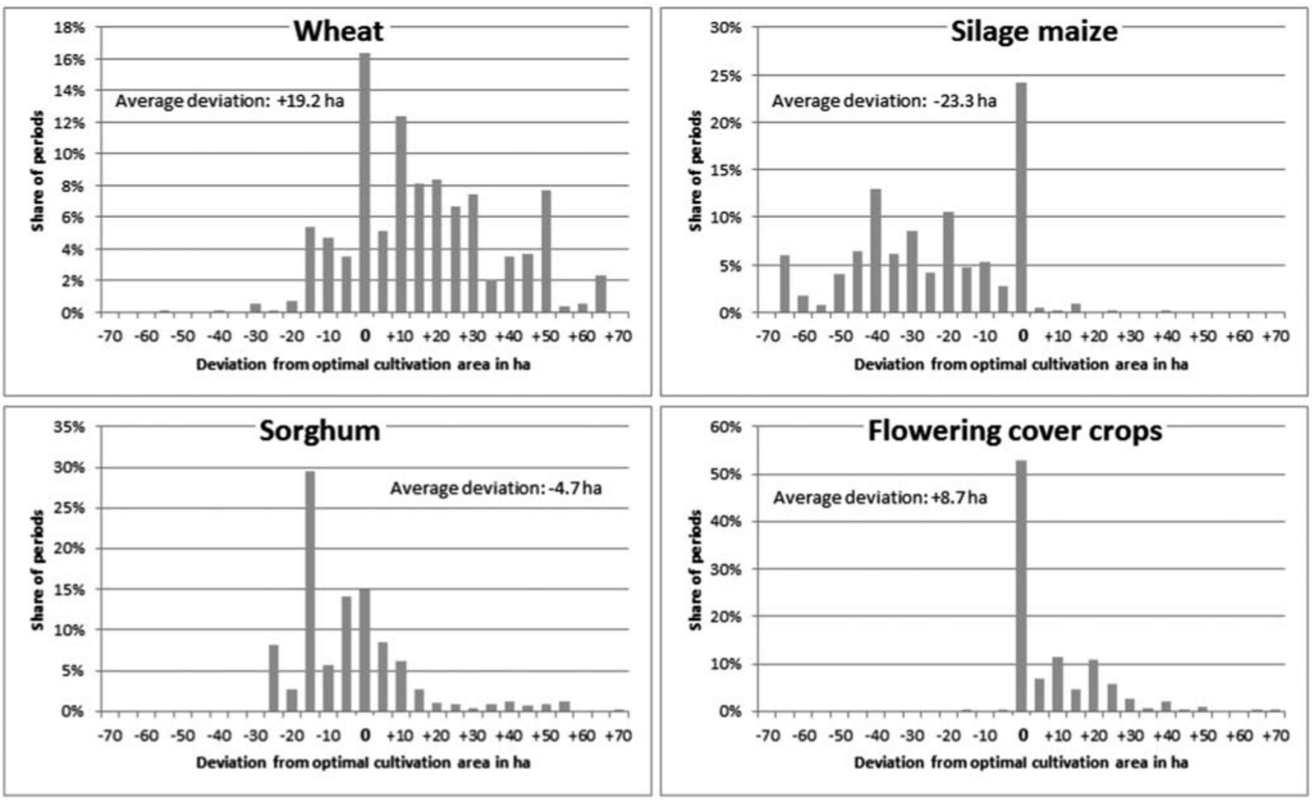

Figure 3: Deviations from the optimal cultivation areas (N=738 production program decisions)

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Table 5: Between Regression of the subject-specific variables on the reached relative economic performance (N=123 farmers)

	Coefficient	t-statistics [(a)]
Constant	77.858	11.610***
Age (in years)	0.093	1.158
Gender	−5.951	−2.177**
Years of education	−0.214	−0,631
Agricultural education [(b)]	2.238	1.185
Economic study focus [(c)]	4.582	2.440**
Manager/successor [(d)]	5.508	2.841***
HLL-value [(e)]	−0.148	−0.350
Consistency of lottery decisions [(f)]	7.927	3.323***
Evaluation of supply contracts [(g)]	−1.601	−1.767*
Evaluation of agri-environmental measures [(h)]	−0.210	−0.218
Subjective farm comparison [(i)]	−0,008	−0.231
Farm is main source of income	0.402	0.152
Farmland in ha	0,000	0.184
Farm type [(j)]	−1.398	−0.684
Time needed to complete the business simulation game (in minutes)	0.021	0.515
F-value	3.975***	
R^2	0.358	

Notes:
(a) *=p-value<0.10; **=p-value<0.05; ***=p-value<0.01.
(b) 1=completed an agricultural training; 0=no completed agricultural training.
(c) 1=economic study focus; 0=other study focus or no study degree.
(d) 1=farm manager or farm successor; 0=other position.
(e) 1–3=risk seeking; 4=risk neutral; 5–9=risk averse.
(f) 1=without multiple switches between the lotteries in the Holt-and-Laury lottery; 0=with multiple switches between the lotteries.
(g) What is your opinion about the conclusion of supply contracts? 1=completely against to 5=completely in favour.
(h) What is your opinion about agri-environmental measures? 1=completely against to 5=completely in favour.
(i) How do you evaluate your farm in comparison to other farms? 0=very under-average to 100=very above-average.
(j) 1=arable farm; 0=processing/forage/others.

identified as a reason for the deviation of the profit-maximising cultivation programmes.

Thus, Hypothesis H2 cannot be supported: Farmers do not choose production programmes with reduced income risk and accept less expected income than what would be possible.

Reasons for the differences in the relative economic performance reached may possibly be based on personal characteristics of the participants different from risk attitude. In the following, these inter-subjective differences will be investigated in more detail.

The high significance of the factor 'gender' in the regression shows that male participants reached a result that is on average 6.0 percentage points higher than the result of female participants. This fact is in contrast to the findings of Johnson and Powell (1994) who stated that male and female managers make decisions of similar quality. A gender-specific analysis of the production programme decisions shows that the tendencies of the deviations from the optimal cultivation areas described in Figure 3 imply that the underlying decision-making patterns are similar for both male and female participants. Nevertheless, women induce significantly higher absolute values of the deviation from optimal cultivation areas than men. Participants with an economic focus in their study degree reached a result that is on average 4.6 percentage points higher than that of farmers who did not hold a university degree or whose degree did not focus on economics. Therefore, it can be assumed that their capacities to process economic information were trained. Farmers who were in a leading position at the time of survey conduction or who expected to take over such a position (manager/successor) reached a relative economic performance that was on average 5.5 percentage points higher than agricultural employees. Also the variable 'consistency of lottery decisions' indicates that relative economic performance of farmers, who switched several times between the lottery A and B during the HLL, was significantly on average 7.9 percentage points less optimal. From a theoretical perspective, there is no reason to switch between the two lotteries offered several times (Holt and Laury, 2002). Therefore, this behaviour leads to the thesis of either insufficient capacities to process information or indicates the participants as not willing to use these capacities to generate optimal solutions. A positive evaluation of the supply contracts diminishes the relative economic performance by 1.6 percentage points per step on a five-step Likert scale. This positive effect of a more pronounced aversion to supply contracts may be a result from the fact that some participants already have had experiences. These farmers possibly better understand the planning problem and, therefore, reach higher values of relative economic performance.

Hypothesis 3 cannot be rejected. That is, differences in the relative economic performance can be explained by socio-demographic and socio-economic characteristics.

7. Conclusions and Future Research Prospects

Many economic models are based on the theory of the *homo oeconomicus* that is often put simple and described as a perfectly rational, profit-maximising decision-maker.

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However, considerable differences exist between the theoretical model results based on this theory and the behaviour of farmers observed in reality. In a realistically designed business simulation game, participants are faced with realistic decision-making situations. On the basis of the results of the game, the present study investigates if farmers act like pure profit maximisers and if they do not, which factors influence their deviation from the highest relative economic performance.

The results show that the behaviour of the participating farmers differs significantly from that of perfectly rational profit-maximising decision-makers. Moreover, risk reducing is not a significant factor but the extent of deviations between the economic performance of individual decisions and highest possible economic performance differs individually. It is true that the socio-demographic and socio-economic factors identified significantly influence the degree of relative economic performance. There are strong indications that, on one hand, bounded rational behaviour plays a role. On the other hand - and this aspect deserves special consideration and requires further research - there are indications to not reduce the model of the *homo oeconomicus* to profit-maximising decision-makers, but also to take into account other useful factors. The deviations between the observed behaviour and the benchmark are not random but systematic. Next to general factors, such as the recreational value or prejudiced thinking, even the possible particularities of the agricultural sector (e.g. the importance of sustainability and environmental protection) need to be revealed and taken into account.

Due to the system of premises and results of models, two different explanatory approaches for the discrepancy between model results and reality derive. On one hand, decisions of the farmers could be assumed as individually optimal and that leads to the existence of multiple, partially unconsidered objectives. On the other hand, the basic assumptions of a model may be accepted as axioms, and bounded rationality of the decision-makers is responsible for deviating results. In order to improve the understanding of decision-making in the agricultural sector and therefore also to improve modelling for policy impact assessment, both explanatory approaches have to be isolated. This may contribute to a more realistic design of models and, thus, of forecasts and policy measures that are based on it. In addition, it may lead to a better understanding of the decision-making behaviour of farmers.

In reference to the planning and implementation of future experiments, some aspects should find special attention. First, the question arises to what extent the experimentally conducted behaviour reflects the situation in practice. Do farmers act similarly in reality and deviate from the aim of profit maximization in order to pursue other activities that are also useful for them? In this context, incentive compatibility plays an important role. Second, business simulation games with economic actors from different sectors carried out under controlled conditions may reveal further general determinants for decision-making as well as the particularities of the agricultural sector. Third, the reasons for certain behaviour or a general 'tactic' in the game should be addressed. It is true that the evaluation of such statements takes up a lot of time. However, appropriate heuristic analysis can help to avoid speculations about the aims of participants and to identify new approaches that have not been considered before.

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