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Economic effects of participation in animal welfare programmes: does it pay off for farmers?

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Abstract

There has been an increased demand by some sections of society for higher farm animal welfare standards. In response, a number of programmes marketing products of animal origin, produced under higher animal welfare standards, have been established on the market in recent years. However, the market segments for products from so-called animal welfare programmes (AWPs) have remained small. Farmers are considered an important stakeholder group for higher market shares of more animal welfare-friendly products. Farmers' decision to adapt their production to the requirements of AWPs is multi-dimensional, but always linked to financial incentives. Since little is known about the financial attractiveness of higher animal welfare standards in livestock farming, this study investigates the perceived economic success of 579 conventional farmers keeping livestock on their farms. The survey data were analysed using propensity score matching to assess the average effect of participation in AWPs on a farm's perceived profitability, liquidity and stability from the farmer's point of view. No significant effect was found of participation in AWPs on the economic success of farmers. The implications of this result are two-fold. On the one hand, it suggests that it is of particular importance to create further financial incentives to encourage farmers to take part in these programmes. On the other, it shows that farmers' concerns that the required costly and highly specific investments will pay off are unfounded, as farmers participating in AWPs rate their own financial situation as equivalent to that of their colleagues not participating in AWPs.

Keywords: *animal welfare, animal welfare programmes, economic effects, farmers, Germany, propensity score matching*

Introduction

In recent years, farm animal welfare has received growing attention, and it's a topic which has become relevant not only to consumers and the media but also to politicians (Nocella *et al* 2010; Lusk & Norwood 2012; Keeling *et al* 2013). Changes in social values in modern societies and the alienation of many consumers from agricultural production have triggered a change in the perception of farm animals (Bauer *et al* 2003; Scholz 2004; Nocella *et al* 2010). Furthermore, recent scientific knowledge in animal health, biology, animal husbandry and animal welfare ethics recognises, more than ever, the intrinsic value of animals and increasingly challenges the human-centric, purely production-oriented view of farm animals (Botreau *et al* 2009a,b; Keeling *et al* 2013; WBA 2015).

In accordance with these developments, the EU 'Action Plan on the Protection and Welfare of Animals' and the large-scale, EU-funded 'Welfare Quality®' research project recommend the enhancement of farm animal welfare (FAW) (EC 2006; Kjærnes *et al* 2007). In several EU member states, reports strongly indicate the need to improve welfare standards for farm animals in conventional production systems, in order to achieve a socially acceptable livestock production (Deimel *et al* 2010; Miele *et al* 2013; WBA 2015). One opportunity for conventional farmers to respond to society's growing concerns regarding farm animal welfare standards is participation in animal welfare programmes (AWPs).

AWPs strive to enhance the level of animal welfare without the use of organic feed and other non-animal welfare-related requirements and, in this way, aim to establish a market segment that is priced between conventional and organic products. Some AWPs market meat, which is produced with standards slightly above the legal requirements, and thus request no or only a small price premium (eg the 'Initiative Tierwohl', 'Beter Leven basic grade', 'Für mehr Tierschutz basic grade'). Other programmes have established considerable improvements concerning FAW and thus require a higher price premium (eg 'Neuland', 'Beter Leven premium grade', 'Für mehr Tierschutz premium grade'). Despite promising signs from various market research studies (eg Schulze *et al* 2008; BMEL 2017a), meat and meat products from AWPs still remain very rare in many European markets and can prove difficult to find in retail outlets. Thus, with

few exceptions (eg Switzerland, the United Kingdom, The Netherlands), these products are yet to attain great significance in the European meat market (Deimel *et al* 2010; Franz *et al* 2012; BMEL 2017a).

This limited market success can be explained by a variety of factors, such as consumer behaviour and acceptance of other stakeholders along the food supply chain (Buller & Cesar 2007; Deimel *et al* 2010; Theuvsen 2011; Franz *et al* 2012).

The long-term success of alternative production systems, such as AWPs, is always highly dependent on stakeholder acceptance and their willingness to participate along food supply chains (Deimel *et al* 2010; Franz *et al* 2012). Farmers are considered an essential stakeholder group for the implementation of AWPs as it remains their decision whether or not to convert their production and participate in AWPs. However, committing to such a decision is multi-dimensional and complex (Darnhofer *et al* 2005; Cranfield *et al* 2010).

Previous studies have shown that non-monetary factors, such as social norms and values, peer pressure, access to information, as well as past experiences strongly influence farmers' behaviour and thus the probability of converting to a new production system (Vaarst *et al* 2002; Palczynski *et al* 2016). Other, non-monetary factors, such as taking pleasure in healthy animals, producing high quality products, being proud of a healthy flock, and working under improved working conditions, are also strong motivators to adapt the current production system to one promoting higher animal welfare standards (eg Huijps *et al* 2010; Leach *et al* 2010; Vetouli *et al* 2012).

The opportunity to reduce the price pressure by earning more per animal and the chance to stabilise trade relations with processors are also cited as motivations for participation in AWPs (Kjærnes *et al* 2007). However, several empirical studies have shown that farmers' willingness to take part in quality programmes, organic farming or AWPs is not just a question of attitude or belief. The decision is also strongly influenced by economic constraints, such as their own financial situation and the long-term success of the farm (Franz *et al* 2012; Hubbard 2012; Swinton *et al* 2015). If the majority of farmers harbour doubt about the economic attractiveness or long-term market success of new production systems with higher animal welfare standards, it will be hard to implement such systems (Bahlmann & Spiller 2008; Deimel *et al* 2010; Franz *et al* 2012; Hansson & Lagerkvist 2012). Financial incentives therefore constitute a major influence for farmers when making production decisions.

To the best of our knowledge, the financial impact of participation in AWPs has yet to have been studied. To address this, our study analyses whether farmers who already participate in AWPs consider their economic success to be more satisfactory than conventional farmers not participating in AWPs. The analysis employs propensity score matching (PSM) to assess the average treatment effect on the treated (ATT) for participation in AWPs, taking into account their effects on farm profitability, liquidity and stability from the farmers' point of view. The econometric analysis was based on a standardised questionnaire circulated among 578 German conventional livestock farmers via an online survey in the (northern hemisphere) summer of 2014.

German farmers were chosen because livestock production is a very important agricultural sub-sector in Germany (DESTATIS 2015). Germany is one of Europe's leading meat and milk producers and a major exporter of products of animal origin (BMEL 2011, 2015, 2017b). Furthermore, the topic of animal welfare is highly controversial in German society, and experts from miscellaneous disciplines have concluded that socially acceptable meat production will only be possible in Germany in the long run if significant changes are made to livestock-keeping (Deimel *et al* 2010; Miele *et al* 2013; WBA 2015). Results from Germany can, therefore, provide important evidence regarding the future of livestock production in other European countries. This study focuses on conventional farmers because public criticism mainly concerns intensive production systems, whereas consumers attribute higher animal welfare standards to organic livestock farming (Harper & Makatouni 2002; Makatouni 2002; Busch *et al* 2013). Furthermore, products of AWPs are mostly developed to establish a kind of middle segment in the market, which lies between conventional and organic products in terms of price. Participation in these programmes is, hence, only economically viable for conventional farmers.

This study complements previous research by identifying the economic effects of AWPs on farmers. The results are used to derive recommendations and managerial implications for farmers, food retailers and standard setters.

Materials and methods

Data and sampling procedure

For this study, German poultry, pig and dairy farmers throughout the entire country were surveyed via means of a standardised online survey. Respondents were recruited via various mailing lists and in collaboration with several German agribusiness trade organisations. In this way, farm owners/managers were able to be reached as occupational email addresses were used. To avoid two individuals from the same farm participating in the survey, the link leading the farmer to the online survey was only able to be used once. After eliminating incomplete questionnaires and farmers not keeping animals, 579 data sets of conventional farmers were left for calculation. Overall, 58 of the conventional farmers surveyed took part in AWPs. These AWPs are not organised or funded by the German government but established by different companies from the private sector, such as slaughter companies (eg Aktion Tierwohl by Westfleisch, Privathof by Wiesenhof), food retailers (eg Gutfleisch by Edeka), the fast-food chain McDonalds (Best beef) or the association for animal-friendly and eco-friendly livestock production (Neuland).

The survey included several modules on the topic of animal welfare as well as questions about farm characteristics and farmers' personal characteristics. Furthermore, farmers were asked to rate statements about the succession of their farms in the next generation. Additionally, farmers' satisfaction with the economic situation of their farms was explored using

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five-point Likert-scaled statements concerning parameters of farm profitability, liquidity and stability. In this way, farmers judged their own economic situation in subjective terms.

The farmers who participated in our survey were, on average, 46 years old, and 84% of them were male. These numbers closely match the projections of the German Federal Statistical Office that state the majority of persons working in the German agricultural sector are male (DESTATIS 2017a). The farmers surveyed have considerable experience, with more than 56% directly involved in farming for more than 20 years. The majority of the participants were from Bavaria (25.2%), Lower Saxony (20.2%) and North Rhine-Westphalia (13.3%). According to the agricultural census of 2013, these federal states have the highest number of livestock (DESTATIS 2014). For 91.6% of the participants, agriculture is the main source of income, compared to the overall German average of only 54% (DESTATIS 2013). The average farm size is 220.76 hectares. The farms in the survey are, therefore, substantially larger than the average size of a German farm (DESTATIS 2017b). Our sample, thus, is not representative of current German livestock farmers, which is not surprising given our sampling procedure. Our respondents were sourced from mailing lists of German agribusiness trade organisations, which mainly contain full-time livestock farmers owning larger farms. The exact definition of the variables can be seen in Table A1 (see the Appendix in the supplementary material to papers published in *Animal Welfare*; https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material).

Evaluation problem and conceptual framework

A farmer chooses to adapt his production system, implementing the requirements of AWPs if the expected utility gained from adoption (U_1) is greater than the utility of non-adoption (U_0). The utility gain (U_1–U_0) can be calculated based on observed characteristics (X) and an unobserved stochastic disturbance term (ε), such as;

$$U_i = X_{iY} + \varepsilon \quad (1)$$

$$Y_i = 1 \text{ if } U_i > 0, \quad (2)$$

where Y_i is a binary indicator that takes a value of 1 if farmer participates in an AWP and 0, otherwise. Farmers' utility gain cannot be directly investigated as it is a latent variable. However, we assume that a farmer participates in AWPs if the utility from participation P_i is greater than zero and does not participate if it is not (Müller & Theuvsen 2015).

The estimation of the causal effect of participation in AWPs (treatment) on the perceived economic success (outcome) requires comparing a group of participants (treatment group) to a group of non-participants (control group). In experimental studies, it is possible to form a control group that has characteristics similar to those of the treatment group. In the case of random assignment of the treatment and control group, the average effect can be calculated by a *t*-test, comparing the mean differences of the outcome variables. In non-experimental studies, treatment and control group might differ in many characteristics that also influence the outcome. Directly calculating the ATT as the mean difference of the outcomes between participants and non-participants leads to biased results (Caliendo & Koepeinig 2008; Pufahl & Weiss 2009). In this paper, treatment and control group are not randomly assigned. Therefore, in order to calculate differences in outcomes that can be clearly attributed to treatment, we had to find a large group of control units similar to the treatment group in all relevant explanatory characteristics apart from treatment. We used propensity score matching (PSM) to control for selection on observable characteristics and to make participants in AWPs statistically comparable to other conventional farmers.

Our choice of explanatory variables is attributed to previous empirical studies on participation in AWPs, broader quality programmes and organic farming, as all of these programmes aim — amongst other things — to enhance the level of farm animal welfare. As shown in Table A1 (https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material), these variables include socio-demographic and farm characteristics.

Previous studies have shown that gender is an important factor influencing participation (Franz *et al* 2012). Furthermore, age, experience and education significantly influence farmers' desire to participate (Gocsik *et al* 2014). At the farm level, farm size, production volume and off-farm income play important roles in the production decision (Bock & van Huik 2007; Gocsik *et al* 2014). Even the type of production and the animal species kept are essential for farmers' production decisions (Skarstad *et al* 2007; Hansson & Lagerkvist 2012). Darnhofer *et al* (2005) showed that different areas in Austria have different percentages of organic farms. This indicates that farm location also plays a role in decisions about the production system.

Moreover, Möhring *et al* (2011) found there to be a strong relationship between the financial success of a farm and ensured farm continuation into the next generation. Since converting to participation in an AWP is associated with costly long-term investments, the farm's continuation into the next generation might also affect this production decision.

We used the perceived financial success of a farm from the farmer's point of view as an outcome variable. Several studies have shown that converting to different kinds of quality programmes is strongly linked to financial incentives (Kjaernes *et al* 2007; Skarstad *et al* 2007; Franz *et al* 2012; Hubbard 2012; Swinton *et al* 2015). Therefore, five variables were used to describe farmers' satisfaction with the profitability, liquidity and stability of their farm as relevant performance indicators. With the help of principal component analysis, we generated a factor comprising these five variables to display the overall perceived economic success of farm (for a definition of outcome variables, see Table A1; https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material). The estimated

Kaiser-Meyer-Olkin (KMO) criterion is 0.844, showing that factor analysis meets the common quality requirements (Hair *et al* 2010). In this way, we were able to investigate the long-term economic situation of the farms from the farmers' point of view.

Propensity score matching

The objective of this study was to quantify the effects of participation in AWPs on various components of the perceived economic success of a farm. Since our research design was non-experimental, we used PSM to find non-participants in AWPs who were as similar as possible to the participants (Rosenbaum & Rubin 1983; Smith & Todd 2005; Caliendo & Kopeining 2008; Adebaw & Haile 2013). Our first step was to find variables that significantly influenced participation in AWPs in this sample by running partial probit models with one explanatory variable (observable characteristic) each. The second step was to estimate the propensity score which, for our purposes, is defined as the conditional probability that a farmer will participate in an AWP.

$$p(X_i) = Prob(P_i = 1|X_i) \quad (3)$$

We calculated the propensity score $p(X_i)$ with the help of a probit model:

$$Y^* = X\beta + \varepsilon, \quad (4)$$

with Y^* representing the underlying variable of P. X is an incidence matrix linking effects of observable characteristics β to observations. ε is an unobserved stochastic disturbance term.

All characteristics showing significant differences between participants and non-participants in the partial models were included to regress participation in AWPs (1 = participants and 0 = non-participants) on the characteristics that influence participation. However, as suggested by Heckman *et al* (1998), we dropped variables from the full probit model, which became statistically insignificant at the 5% level.

We measured the performance of our model using the receiver operating characteristic (ROC) curve (Park & Kellis 2015). An ROC curve is a graph of the true positive rate (TPR, ie number of true positive decisions/number of actually negative cases) dependent on the false positive rate (FPR, ie 1–[number of true negative decisions/number of actually negative cases]) (Metz 1978). As explained by Pencina *et al* (2008), the area under this curve can be interpreted as the probability that two subjects randomly chosen from each group (treated/non-treated) will be ranked correctly by the predicted probability from the model. In contrast to the measure of accuracy, the area under the ROC curve is independent from treatment frequency and decision threshold effects (Metz 1978).

In our study, we evaluated the average treatment effect on the treated (ATT) to answer the question 'How much do farmers who participate in AWPs benefit economically compared with non-participants in AWPs?' ATT is defined as:

$$ATT: E(Y_i|P = 1) = E(Y_{i1}|P = 1) - E(Y_{i0}|P = 0) \quad (5)$$

where $E(Y_{i1}|P = 1)$ is the outcome for farmers participating in AWPs and $E(Y_{i0}|P = 0)$ is the outcome for conventional farmers not participating in AWPs (Caliendo & Kopeinig 2008; Müller & Theuvsen 2015).

Two conditions have to be met when using PSM: the conditional independence assumption (CIA) and the common support in propensity scores across samples of treated and non-treated farmers (Heckman *et al* 1997). We tested the common support assumption by plotting histograms of the estimated propensity scores for both participants and non-participants in AWPs in order to check whether regions overlap. Concerning the first condition, it is not possible to directly test the CIA condition with non-experimental data. In the presence of unobserved variables, which affect selection into treatment and control group as well as the outcome variables, results may be biased. A violation of the CIA is, however, less likely when the major influencing variables are included (Rosenbaum 2002; Adebaw & Haile 2013).

We applied three matching algorithms, using r-package matching, each with two different variations to check the robustness of our results (Jasjeet & Sekhon 2011). We carried out nearest neighbour matching with replacement (1 neighbour/5 neighbours), caliper matching (caliper 0.05/0.09) and radius matching (caliper 0.05/0.09) to pair participants in AWPs to comparable members from the control group using propensity scores. In nearest neighbour matching, one/five farmer(s) from the control group is/are chosen as a matching partner(s) for a treated farmer who is/are closest in terms of the propensity score. One potential risk of nearest neighbour matching is that bad matches occur if the nearest neighbour is far away. To avoid bad matches, a tolerance level on the maximum propensity score distance (caliper) can be imposed. Using caliper matching means that a farmer from the control group is chosen as a matching partner for a treated farmer who lies within the caliper (in our case 0.05/0.09) and is closest in terms of the propensity score. An often-used variant of caliper matching is radius matching. In radius matching, not only is the nearest neighbour within the caliper used but all of the farmers from the control groups within the caliper (Caliendo & Kopeing 2008). Furthermore, we conducted balancing tests to check whether PSM was able to remove significant differences between treatment and control group for all covariate means.

In our sample, only 58 farmers took part in AWPs and the ATT are, therefore, calculated on the basis of a relatively small sub-sample. However, the results of Pirracchio *et al* (2012) showed that propensity score matching yields correct estimations of treatment effects even for small study samples or low prevalence of treatment.

Results

Descriptive statistics

Table 1 provides means for the outcome variables as well as for personal and farm characteristics of our sample for participants and non-participants in AWPs and shows the results of the partial probit regressions concerning significant differences in the probability of participation in AWP.

No significant differences between participants and non-participants of AWPS can be found with regard to the outcome variables. The perceived economic success and the underlying variables' overall operational situation, satisfying profit, financial obligations, long-term payment

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Table 1 Descriptive statistics of sample farmers by participation/non-participation in AWPs and results of partial probit regressions.

Variable[†]	Means		Significance[‡]
	Participants	Non-participants	
Outcome variables			
Economic success	0.080	–0.027	
Overall operational situation	0.92	0.84	
Satisfying profit	0.54	0.49	
Financial obligations	1.23	1.13	
Long-term payment security	1.00	0.88	
Equity capital	0.64	0.65	
Personal characteristics			
Gender (male = 1)	0.897	0.835	
Average age (years)	46.12	46.14	
Education level			
Low	0.121	0.163	
Medium	0.276	0.332	
High	0.172	0.174	
Very high	0.397	0.303	
Other	0.041	0.028	
Farm characteristics			
Place of residence			
Northern Germany	0.241	0.332	
Western Germany	0.224	0.261	
Eastern Germany	0.052	0.063	
Southern Germany	0.483	0.344	*
Main source of income is farming	0.931	0.914	
0–49 hectares	0.293	0.299	
50–99 hectares	0.414	0.321	
100–199 hectares	0.086	0.184	*
≥ 200 hectares	0.207	0.196	
Type of animals kept			
Laying hens	0.207	0.111	*
Broilers	0.155	0.346	***
Turkeys	0.052	0.031	
Dairy cows	0.414	0.561	*
Beef cattle	0.121	0.199	
Sows and piglets	0.241	0.171	
Porkers	0.345	0.328	
Other animals	0.138	0.148	
Farm continuation			
Ensured	0.448	0.516	
Uncertain	0.552	0.436	
None	0.000	0.048	
Number of observations	58	520	

[†] For exact definitions of variables, see Table A1 (https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material).

[‡] Significance level referring to the results of partial probit regression (dependent variable: participation in AWP): * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$; n = 579.

Table 2 Full probit model results of variables determining participation in AWPs.

Variable†	Coefficient	Standard error	z-value/Significance
Farm characteristics			
Place of residence			
Eastern Germany	0.163	0.354	0.460
Western Germany	0.137	0.215	0.636
Southern Germany	0.511	0.199	2.570*
Farm size			
50–99 hectares	0.474	0.265	1.792
100–199 hectares	0.703	0.262	2.680**
≥ 200 hectares	0.699	0.297	2.352*
Type of animals kept			
Laying hens	0.416	0.211	1.972*
Broilers	0.939	0.291	3.223**
Turkeys	–0.313	0.415	–0.755
Dairy cows	–0.338	0.177	–1.907
Beef cattle	–0.328	0.223	–1.474
Sows and piglets	0.134	0.206	0.652
Porkers	–0.141	0.184	–0.766
Other animals	–0.062	0.220	–0.282
Constant	–1.934	0.303	–6.380***

† For exact definitions of variables, see Table A1 (https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material).
* $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$; n = 579.

security and equity capital (exact definition of outcome variables, see Table A1; https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material) are rated on a comparable level by participants and non-participants of AWPs.

There are, however, significant differences between participants and non-participants of AWPs. Concerning farm size, the share of adopters in the 100- to 199-hectare range is significantly lower compared to non-adopters.

Moreover, laying hens are more likely to be kept on farms participating in AWPs, while broilers and dairy cows are significantly more often kept on non-participating farms. Farmers who adapted their production to the standard of an AWP tend to live more often in southern Germany than non-adopters.

Our results suggest that significant differences exist between farmers that participate in AWPs and those that do not. Hence, a simple comparison of the outcome variables between the two groups leads to biased results as regards the impact of participation in AWPs on economic success. In the following section PSM will be applied to reduce the difference between the two groups and derive unbiased estimates of the effect.

Economic effects of participation in animal welfare programmes

The conditional probabilities for taking part in AWPs were calculated using a full probit model where all characteristics showing significant differences between participants and non-participants were included. All variables in a category (apart from the reference category) were included in the full probit regression model if one or more variables of the category showed significant differences in the partial probit regression (see Table 2).

The set of independent variables used in the probit regression model represents a vector of covariates to calculate the distance in matching observations. Table 2 shows the estimates of the coefficients of the full probit regression. Most of the covariates match with what can be expected from the descriptive statistics. Differences to the partial regression results can be explained by the fact that some variables in the full model are mutually dependent and affect each other.

Only farm characteristics are included in the model, as our descriptive results showed no significant differences regarding personal characteristics between treatment and control groups. Participation in AWPs correlates significantly with place of residence, the size of the farm, and the type of animal raised. Farmers in southern Germany and larger farms are more likely to participate in AWPs. Furthermore, farmers participating in AWPs are more likely to keep laying hens and broilers, while it is less likely that they keep dairy cows.

Our model is statistically significant at the 1% level and correctly ranks 72.45% of the sample observations, which is moderately good (Pencina *et al* 2008). Figure 1 shows the ROC curve.

The overlap assumption for our treatment and control groups is met, as all participants of the treatment group (farmers taking part in AWPs) lie inside the region of

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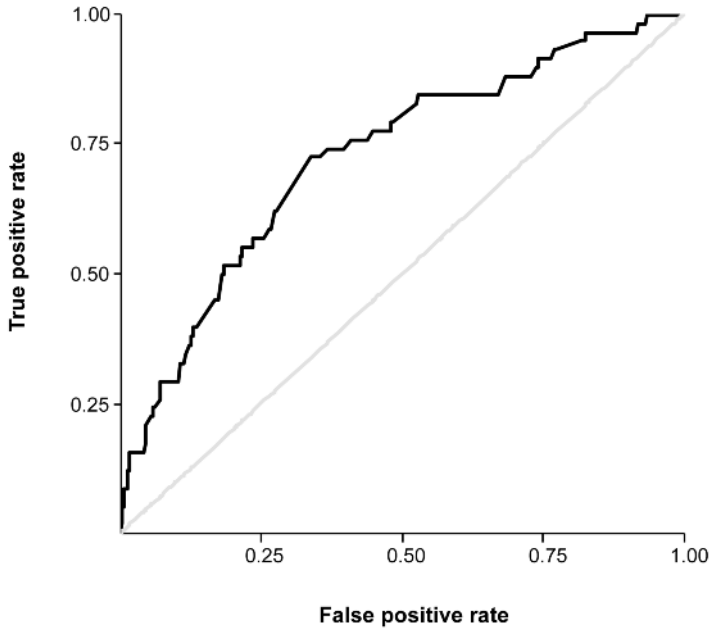
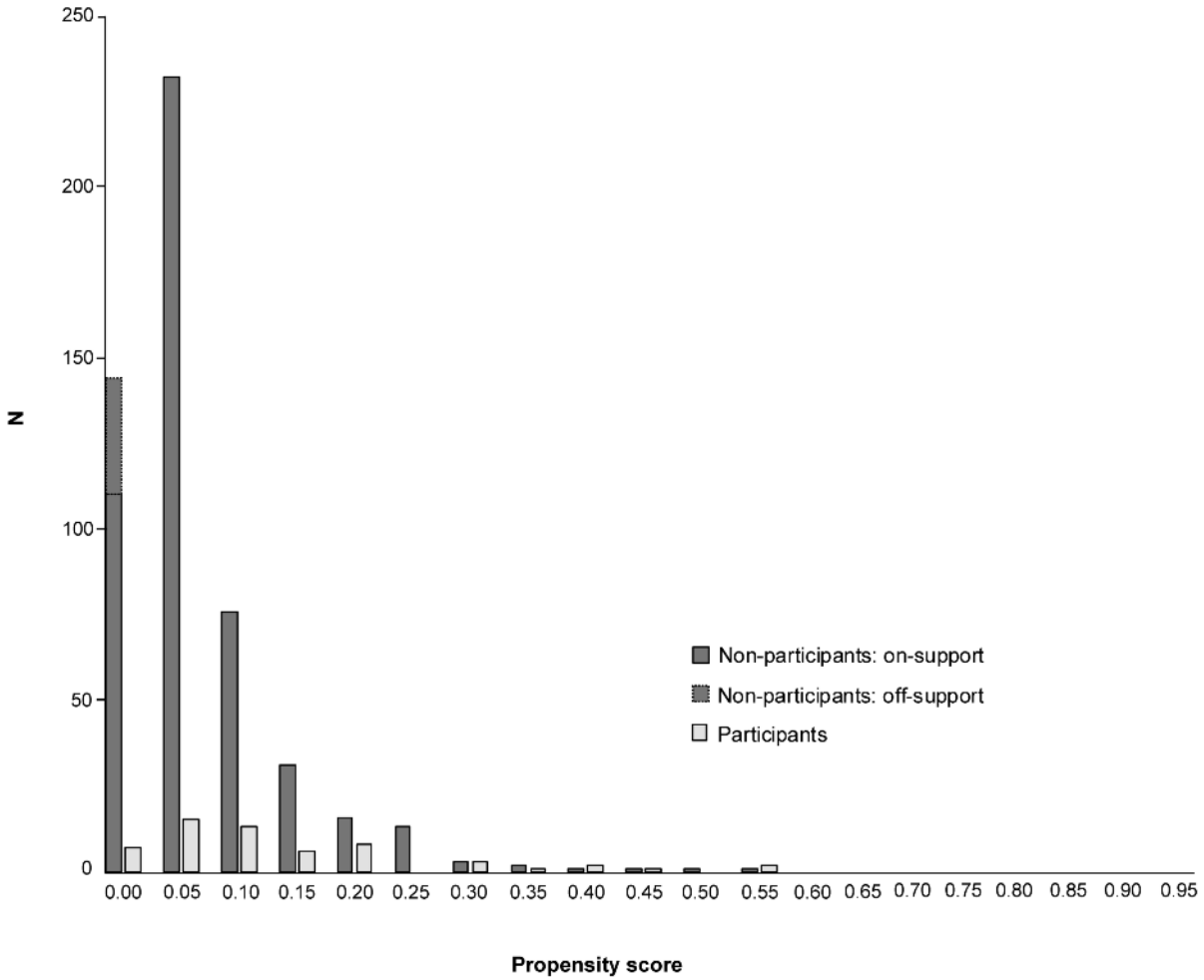
Figure 1



ROC curve for full probit model for participation in AWPs.

Figure 2



Estimated propensity scores and region of common support participation in AWPs.

Table 3 Test of matching quality for participation in AWPs.

Variable†	Means of matched sample		Bias		
	Participants AWP	Non-participants AWP	% Bias	% Bias reduction	*t*-test/*P*-value
Farm characteristics					
Place of residence					
Eastern Germany	0.05	0.03	10.21	15.41	0.26
Western Germany	0.25	0.22	7.42	16.19	0.55
Southern Germany	0.48	0.48	0.31	–27.64	0.97
Farm size					
50–99 hectares	0.31	0.32	–2.83	–1.46	0.68
100–199 hectares	0.39	0.39	–0.90	–19.67	0.93
≥ 200 hectares	0.21	0.17	10.03	7.31	0.39
Type of animals kept					
Laying hens	0.17	0.17	0	23.39	1
Broilers	0.10	0.10	0	33.03	1
Turkeys	0.04	0.03	2.48	–6.93	0.90
Dairy cows	0.46	0.39	13.61	43.14	0.19
Beef cattle	0.14	0.11	7.92	31.94	0.48
Sows and piglets	0.25	0.22	6.69	–9.66	0.60
Porkers	0.35	0.35	–1.60	–5.07	0.89
Other animals	0.12	0.11	1.49	4.33	0.91

† For exact definitions of variables, see Table A1 (https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material).

Table 4 Estimation of ATT for participation in AWPs.

Outcome variable†	Matching estimator	Caliper matching	Radius matching
	Nearest neighbour matching m = 1 (m = 5)	Caliper = 0.05 (0.09)	Caliper = 0.05 (0.09)
Economic success	0.116 (0.180)	0.124 (0.098)	0.192 (0.137)
Overall operational situation	0.101 (0.110)	0.075 (0.054)	0.130 (0.081)
Satisfying profit	0.051 (0.169)	0.018 (–0.001)	0.082 (0.061)
Financial obligations	0.159 (0.139)	0.169 (0.166)	0.152 (0.141)
Long-term payment security	0.162 (0.210)	0.200 (0.159)	0.274 (0.177)
Equity capital	–0.038 (0.072)	–0.003 (–0.002)	0.093 (0.059)

† For exact definitions of outcome variables, see Table A1 (https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material).

common support. Figure 2 presents the region of common support for participants and non-participants in AWPs based on nearest neighbour matching (m = 1).

Matching is regarded as applicable when the differences between covariates among treatment and control group have been eliminated and the bias is less than 20% for each covariate (Rosenbaum & Rubin 1983). Table 3 presents the balancing test, which shows that all significant differences in covariates between treatment and control groups have been removed and that the standardised differences (% bias) of all variables between treated and non-treated farmers are less than 20%. Thus, the balancing assumption is satisfactorily met (Rosenbaum & Rubin 1983).

To identify the ATT of participation in AWPs on our outcome variables, three matching estimators were employed (see Table 4). All three show a slightly positive effect on all outcome variables for farms participating in AWPs, but these results are not significant at the 5% level. The use of the five nearest neighbours and enlargement of the caliper to 0.09 lead to very similar results, showing the high robustness of our results.

Only the possibility of earning equity capital from farming has a slightly negative ATT for participants in AWPs, but again not at a significant level.

The assessment of a farm's economic situation is based on the subjective perception of the farmer. Our analysis does not include objective performance indicators, such as the gross cash farm income. A more optimistic assessment of their economic situation by participants in AWPs cannot be fully excluded. However, the subjective assessment makes it possible to investigate the long-term economic success of farms while objective performance indicators often only give evidence about the current economic status of the farm.

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Discussion

No significant effect of participation in AWPs was found on the economic success of farmers, suggesting that the situation of non-participants is economically comparable to that of participants. The important managerial and policy implications of this result will be discussed as follows.

Firstly, it suggests that the additional costs related to the conversion to AWPs do not negatively affect the short-term ability to earn equity capital. Farmers converting to AWPs face high investment costs, for example, for modification of barns. As most of the AWPs in Germany were only very recently established (except for Neuland), these high investment costs could have had a negative effect on the short-term ability to earn equity capital. Against this background, the non-significant ATT needs to be interpreted as a positive sign that farmers are able to bear the additional costs related to the conversion to AWPs. Secondly, even though farmers participating in AWPs are not motivated solely by financial incentives, economic risks and associated financial disadvantages constitute major barriers for adapting current production systems to the standards of AWPs (Duffy & Fearne 2009; Deimel *et al* 2010; Gocsik *et al* 2015). To receive an even broader consensus among farmers, it is particularly important to create further financial incentives to encourage farmers to take part in these programmes. Participation in AWPs needs more financial support, especially since farmers gain no clear monetary benefits from doing so. Recent scientific research has suggested that EU payments should be re-directed from the first to the second pillar of the Common Agricultural Policy and used to reward farmers who implement higher animal welfare standards (WBA 2015). Other initiatives rely on joint actions by leading retailers who pay a fixed amount per kg of meat sold into a common pool, which is then used to finance higher animal welfare standards on farms (Initiative Tierwohl 2016).

Moreover, farmers face a number of barriers when adapting their production systems to alternative production systems (eg Darnhofer *et al* 2005; Cranfield *et al* 2010). Many farmers are unconvinced that the required costly and highly specific investments will pay off (Duffy & Fearne 2009; Deimel *et al* 2010; Gocsik *et al* 2015). Our study suggests that these concerns are unfounded, as farmers participating in AWPs rate their own financial situation in an equivalent fashion to how colleagues not participating in AWPs appraise their own situation. Thus, participating in AWPs constitutes an economically interesting opportunity for farmers who are in search of new and sustainable production alternatives. In this way, farmers can help to meet societal requirements and reduce the dissent between the broader public and the agribusiness sector and regain consumers' trust in agricultural production.

Furthermore, our results provide evidence that larger farms are more likely to participate in AWPs than smaller farms. These results contrast with previous studies (Bock & van Huik 2007; Knage-Rasmussen *et al* 2013; Lawrence 2013). But due to the higher economies of scale, larger farms might be more readily able to generate additional profit which is important as regards additional investments which are usually necessary to increase animal welfare standards (Lyons 1995). Furthermore, these findings are in contrast with the current perception of many consumers, who often associate a high level of FAW with small-scale family farming (Busch *et al* 2013). Thus, our results strengthen the suggestions of Busch (2016) and Meyer-Hamme (2016) who argue that a public debate about an ideal farm size for higher animal welfare standards is not constructive.

Besides the farm size, the animal species kept as well as the place of residence significantly influence farmers' willingness to participate in AWPs. A previous study by Heise and Theuvsen (2017) also showed that farmers cannot be understood as one homogenous group; but that it is possible to differentiate between three groups of farmers that differ significantly according to their farm animal welfare attitudes, their willingness to participate in AWPs and their socio-demographic and farm characteristics as well as their perception of their own financial situations. These results should be taken into account when interpreting the findings of the current study. It can be expected that there are individual differences between the farmers under study and that financial incentives are not equally important to all investigated farmers as further non-monetary motivations (eg personal, ethical or social considerations) might have influenced farmers' decision as regards production.

This study reveals an important starting point for political and administrative measures, on the one hand to increase the economic attractiveness of AWPs and, on the other, to improve communication between the agribusiness sector and the broader public, thereby seeking to address societal concerns and reduce the dissention between the broader public and the agricultural and food sector. This study, however, also has a number of limitations. Firstly, the study is not fully representative as the sample composition differs compared to the overall population of German livestock producers. The non-representative nature of our sample needs to be taken into account when interpreting the results. However, we used PSM to make participants in AWPs comparable to non-participants. For this, we controlled for all farm characteristics which significantly influenced participation. In this way, our results from PSM allow conclusions to be drawn that are also relevant for other farmers.

Secondly, when using PSM it is not possible to directly test the CIA condition. Thus, a certain bias through unobservable variables that affect selection into treatment and control group as well as the outcome variables might still exist. We tried to minimise biased results by matching on the area of common support and testing the balancing property. This reduces bias, but does not prevent it.

Most of the AWPs in Germany were only very recently established. This could negatively affect the short-term economic situation of the participating farms as long-term investments have not paid off until now and the efficiency

of the entire supply chain for products from AWPs still needs to be improved. For this reason, the participants in AWPs in our study may face first-mover disadvantages, that is, the cost penalties experienced by the first entrants into a new market segment (Boulding & Christen 2001).

Finally, we calculated our ATTs based on variables that reflect the subjective perception of a farm's economic success from the farmer's point of view. Our analysis does not include objective performance indicators, such as the gross cash farm income. Previous studies have shown that organic farmers are considered to be less risk averse than conventional farmers (Gardebroek 2006). There might be similar differences between participants and non-participants of AWPs. Therefore, it cannot be fully dismissed that participants in AWPs might rate their own economic situation more optimistically than their conventional colleagues not participating in AWPs.

Animal welfare implications

Conventional farmers participating in AWPs currently rate their economic situation comparable to conventional farmers not participating in AWPs. These results can help to convince even more farmers to take part in AWPs, thereby creating a broader market segment for products with higher animal welfare standards, enabling a large number of farm animals to live under improved conditions.

Conclusion

This study analysed the impact of participation in AWPs on the subjective economic success of farmers which, to the best of our knowledge, has not yet been studied. Our results suggest that participation in AWPs currently constitutes a financially equivalent production alternative, as farmers participating in AWPs rate their economic situation comparable to those not participating in AWPs. This study is, by definition, explorative and, as such, represents a starting point for further research. Previous studies have shown financial incentives to create a major influence on farmers' willingness to adapt their production to the requirements of specialised AWPs. However, other, non-monetary motivations can also influence farmers' production decision (eg Huijps *et al* 2010; Leach *et al* 2010; Vetouli *et al* 2012; Palczynski *et al* 2016). These non-monetary incentives were not studied here and, thus, require to be investigated in more detail in further studies in order to create an appropriate mixture of monetary and non-monetary incentives for farmers to convince as many of them as possible to take part in programmes requiring higher animal welfare standards.

Future research should also include objective performance indicators to check whether or not farmers' subjective perceptions are in line with these indicators. Furthermore, it would be interesting to investigate and compare the economic effects of participation in different AWPs in order to find the most financially attractive AWP for farmers. Another relevant point for further studies would be to estimate propensity scores and ATTs separately for the different animal species kept on the farm to be able to give more specific recommendations to farmers.

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