Assessing consumer and producer preferences for animal welfare using a common elicitation format.

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Abstract

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1 Introduction

The ongoing debate on farm animal welfare (FAW) has led to numerous initiatives aiming at enhancing the welfare of farm animals. Well-known examples are the *Welfare Quality*® standard in Europe, the chain-wide Quality and Safety (QS) certification system and the *Initiative Tierwohl* (Animal Welfare Initiative) in Germany (DBV 2015). Although high-welfare meat is available on the meat market in most EU countries and some consumer groups are willing to pay premium prices (Meuwissen et al. 2007; Spiller and Schulze 2008; Lagerkvist and Hess 2011), actual consumption of welfare-enhanced meat accounts for a mere two percent of the German meat market, including organically produced meat (Spiller et al. 2010). Franz, Meyer and Spiller (2010) argue that product differentiation starts at the farm level. Producers' participation in animal welfare initiatives thus is a prerequisite for success. However, higher animal welfare standards mean additional costs for farmers (Liljenstolpe

2008). Thus, deciding on the economically viable level of FAW requires trade-offs to be made between better animal well-being and profitability of livestock production.

The present study aims to identify the factors affecting pig farmers' acceptance of FAW programmes as well as the factors influencing consumers' purchase behaviour of high-welfare pork[1]. We are particularly interested in estimating and comparing producers' willingness-to-accept compensation in the form of higher prices and consumers' willingness-to-pay. The analysis is based upon Discrete Choice Experiments (DCE) with 140 pig farmers and 775 consumers in Germany. This paper contributes to the literature by combining demand and supply side estimations using a common elicitation format. We use nearly identical choice sets for both the farmer and the consumer survey. This approach allows us to simulate the market for pork produced under alternative FAW enhancing programmes. The following Section 2 sets out hypotheses based on a review of the relevant literature. Section 3 describes the common elicitation format and provides details of the survey. Section 4 explains the econometric estimation approach. Results are presented and discussed in Section 5. Section 6 concludes.

2 Literature and hypotheses

Lagerkvist and Hess (2011) provide a comprehensive review of studies estimating consumers' willingness-to-pay for enhanced FAW. They emphasise that information on how farm animals are kept can alter purchase behaviour. Meuwissen and van der Lans (2004) conducted a conjoint analysis among Dutch pork consumers and found that respondents were willing to pay a price premium for attributes related to animal welfare, although these attributes are less important than price and taste. Lagerkvist et al. (2006) compared Swedish consumers' preferences for immuno-castration of pigs, surgical castration and abstention from castration. Their results suggest that consumers attach greater value to pork from immuno-castrated pigs than from those who are surgically castrated. In contrast, pork from intact boars was negatively valued because of an increase in potential risk of boar taint.

Similar results were found by Liljenstolpe (2008) who consider "no castration" as a food safety attribute due to increased risk of boar taint. Furthermore, Swedish consumers were found to be willing to pay an increment for mobile slaughtering to avoid transportation of

[1] The term high-welfare or welfare-enhanced pork (or meat) refers to production conditions above the legal minimum standard.

living animals. These studies demonstrate that nearly all of the investigated measures to enhance animal welfare are positively valued by consumers. We thus hypothesise:

HC1: The higher the requirements of a FAW programme the more likely consumers are to purchase high-welfare pork.

Meuwissen and van der Lans (2005) investigate consumers' trade-offs between different pork meat by means of a conjoint analysis. Although they could identify consumer segments that are more concerned about food safety and animal welfare, taste and price were on average perceived as the most important characteristics. Other studies support the view that price weighs heavily on purchase decisions (Grunert 2006; Jonge and van Trijp 2013). This leads to:

HC2: Higher prices of high-welfare pork reduce the likelihood of purchase.

It is well known that socio-economic characteristics and attitudes, values and beliefs influence purchase behaviour. For example, Enneking (2004) finds that respondents who pay attention to animal-friendly production methods also prefer premium brands or organic products to cheap private labels and less well-known brands. We thus hypothesise:

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

Considering that, in Germany, supermarkets account for a market share of 80% in meat sales, Weinrich et al. (2015) investigate the attractiveness of alternative points of sale and reveal that high-welfare meat is not successfully sold at the self-service counter. Hence:

HC4: Consumers who prefer to buy meat at the service counter are more likely to purchase high-welfare pork.

We further hypothesise in line with Spiller and Schulze (2008) that the respondents' gender, their expenditure share on food and the frequency of meat consumption will affect the purchase of high-welfare pork.

Farmers' preferences for FAW programmes in pork production have rarely been investigated. Although an increasing number of studies deals with farmers' general attitudes towards animal welfare (Austin et al. 2005; Bock and van Huik 2007; Lagerkvist et al. 2011; Franz et al. 2012), little is known about farmers' willingness to participate in FAW programmes. Franz et al. (2012) identified three different groups of pig farmers who all showed a broad acceptance of the basic principles of the European initiative *Welfare Quality*®. Only one

group attached importance to appropriate animal behaviour, indicating differences in the understanding of animals' well-being. Vanhonacker et al. (2008) found heterogeneous perceptions of FAW among farmers: while some were mostly profit-oriented, others mentioned the supply of high-quality products, job satisfaction and creating a more positive image of their profession among the public as motivating factors. We are aware of only two studies that apply the DCE technique to assess livestock farmers' preferences for quality system requirements. Norwood et al. (2006) use a DCE to study cattle producers' acceptance of voluntary check-off programmes. Participation in such check-off programmes depends significantly on the refund mechanism for fees that are paid voluntarily in advance. Schulz and Tonsor (2010) investigated US cow-calf producers' preferences for voluntary traceability systems, managed either by the private sector or by the government, and varying in the level of information to be supplied by the producers. In both studies, a premium paid to encourage farmers' participation was highly valued. We thus claim:

HP1: A higher producer price increment for welfare-enhanced pork increases the likelihood of participation in a FAW programme.

The feasibility of FAW measures depends on farm-specific resource settings such as barn space or access to open space. Creating the husbandry conditions required by a FAW programme can be costly, and the costs will vary from farm to farm. We thus hypothesise:

HP2: The more effort and resources are needed to comply with a FAW programme, the less likely farmers will participate.

HP3: The more demanding the requirements of the FAW programme, the less likely farmers will accept the programme.

Direct marketing provides good opportunities to convey positive images of ethical animal husbandry to consumers. This leads to:

HP4: Farmer who are engaged in direct marketing are more likely to participate in a FAW programme.

We further hypothesise that the respondents' socio-economic characteristics like educational status or age affect farmers' willingness to take part in a FAW programme.

3 Methodology

3.1 The Discrete Choice Experiment

The empirical analysis is based upon two nearly identical Discrete Choice Experiments with 140 pork farmers and 775 consumers in Germany. Both surveys were conducted in 2014 using online questionnaires. Farmers were motivated to participate through a call on the University's homepage and a mailing list of a farmers' union in Lower Saxony. The consumer survey was conducted by a marketing research company which collected questionnaires from 554 individuals. The consumer survey was augmented with face-to-face interviews in a shopping centre in northern Germany (N= 221). Although a total of 779 respondents took part in the consumer survey, we included only 775 responses in the analysis; the remainder stated that they usually never consume pork.

Table 1 shows the animal welfare attributes included in the choice sets. Programme attributes in terms of FAW requirements for pig producers were derived from existing FAW initiatives in Germany[2] and comprise the surface area per pig, supply of bedding straw, access to manipulable and rooting material, tail docking and castration, and the maximum transport time to the abattoir. The minimum levels of the respective attributes were defined by the statutory requirements and the German quality and safety (QS) standard. These are marked with an asterisk in Table 1. The upper levels were set in accordance with the FAW requirements of organic agriculture. Higher FAW standards benefit the pigs but are costly for the farmer. For instance, more space per animal means less stress for the pigs and, in consequence, reduced incidence of tail biting and other forms of atypical animal behaviour. The costs were quantified in a master thesis which also derived producer price increments required to offset the negative financial effects (Becker, 2014). We used these price increments to calibrate the price attribute in the choice experiment. The producer price increment to be paid on top of the reference price (€1.70/kg) reflects the range of costs arising from implementing the different FAW requirements.

For the consumer choice sets, a reference price of seven Euros per kilogram pork cutlet was chosen. The upper level for the consumer price was set near the price of organically produced pork (€14/kg). The choice sets for the consumer and the producer survey were identical in all attributes and attribute levels except for the price increment variable.

[2] The FAW programmes *„Initiative Tierwohl", Tierschutzlabel für mehr Tierschutz"* and *„Aktion Tierwohl"* comprise different requirements for the keeping of pigs, animal surgery and transportation to abattoirs.

At the beginning of the experiment, respondents were provided with information regarding the animal welfare attributes and what they mean for animals and consumers and we further made it clear that they were faced with purchasing decision. It was also made clear in surveys that the options on offer referred to individual choices and must not be taken as an obligation for all German pig farmers.

The *orthoplan* procedure of SPSS was used to generate an orthogonal design, yielding 81 choice sets. We then checked each choice set for utility balance and removed one choice set which contained a dominant choice alternative. The experimental design comprising 80 choice sets had a D efficiency score of 97.1, indicating a satisfying design (Kuhfeld, 2004). Of the 80 choice sets, eight were randomly chosen per respondent. In each choice set, respondents were asked to choose among two hypothetical FAW programmes and a status quo representing the QS minimum FAW standard (see Table 2). Moreover, consumers were asked to provide information on their consumption behaviour, their attitude towards FAW and socio-economic characteristics. Pig farmers were asked to provide information about their resource settings, socio-economic parameters, their general attitude towards animal welfare labels, and if they were generally willing to participate in a FAW programme.

Table 1: FAW attributes and levels used in the consumer and producer DCE

Attribute	Level[3]
Surface area per animal (m^2 per animal)	1) 1.00*; 2) 1.33; 3) 1.66; 4) 2.00
Characteristics of piggery floor	1) Slatted floor without bedding straw*; 2) Bedding straw in part of barn area; 3) Bedding straw in entire barn area
Manipulable material	1) One piece of manipulable material* 2) Three pieces of manipulable material 3) One piece of manipulable material and rooting material
Surgery	1) Tail docking and castration without anaesthesia* 2) Tail docking and castration with anaesthesia 3) No surgery
Duration of transport to abattoir	1) 8 hrs.* 2) 6 hrs. 3) 4 hrs.
Consumer price for pork cutlet in €/kg	1) 7.00* 2) 8.40 3) 9.80 4) 11.20 5) 12.60

[3] *marks the minimum level (status quo)

	6) 14.00
Producer price increment in €/kg carcass weight on top of reference price €1.70/ kg	1) 0.00* 2) 0.08 3) 0.16 4) 0.24 5) 0.32 6) 0.40

Table 2 Example of a choice set including two FAW alternatives and the status quo

FAW requirements	QS standard (Status Quo)	FAW programme 1	FAW programme 2
Producer price increment €/kg carcass weight // Consumer price for pork cutlet in €/kg	0.00 €/kg // 7.00€/kg	0.24 €/kg // 11.20€/kg	0.32 €/kg // 12.60€/kg
Surface area per animal (m^2 per animal)	1.00 m^2	1.00 m^2	1.66 m^2
Characteristics of piggery floor	Slatted floor without bedding straw	Straw bedding (full barn area)	Straw bedding (full barn area)
Manipulable material	One piece	One piece	Three pieces
Surgery permitted	Yes, without anaesthesia	Yes, without anaesthesia	Yes, with anaesthesia
Max. duration of transport to abattoir	8 hrs.	6 hrs.	8 hrs.
I would choose:	□	□	□

3.2 Econometric estimation

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

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

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

(2) $$P_{nj*} = prob\left(V_{nj^*} + \varepsilon_{nj^*} > V_{nj} + \varepsilon_{nj}\right) \forall\, j = J; j^* \neq j$$

The deterministic part V_{nj} can be described as an additive function of FAW requirements x_{nj} providing different levels of utility. In addition, we assume that the decision makers' personality and the farm resource settings or the household structure z_n can affect the likelihood of choosing a FAW alternative.

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

Constant α_c captures the average effect on utility of all unobserved factors associated with the FAW programme. Estimated parameters α and β (summarized under the designation γ_n) provide information on the influence of the FAW attributes and personal or farm characteristics on the choice probability. To account for heterogeneity within the population, a Random Parameter Logit (RPL) model was employed which overcomes the limitations of a standard logit model by allowing for random taste variation, unrestricted substitution patterns and correlation in unobserved factors (Train 2003). The utility parameters γ_n vary across the population with density $f(\gamma|\theta)$ where θ are the true parameters of the distribution describing the mean and the variance of γ's. The attributes of the FAW programme are included in the model as random parameters, and the personal/farm characteristics interact with constant α_c because they do not vary across alternatives (Hanley et al. 2001). The estimated coefficients do not have a direct interpretation other than in their signs or statistical significance (Burton et al. 2001). We used the coefficients to derive WTP and WTA estimates as the negative ratio of the coefficients of the attribute variable of interest x_j and the price variable:

$$WTA\ or\ WTP\ for\ x_j = -\frac{\alpha_{xj}}{\alpha_{price}} \quad (4)$$

These WTP/WTA estimates are calculated at the mean of the sample. We also compute individual WTP and WTP values, which we need for deriving supply and demand curves for FAW in Section 5. In order to account for statistical variability in WTP/WTA estimates, confidence intervals of 5% and 95% for mean values were computed using the delta method recommended by Hole (2007).

4. Results

4.1 Descriptive statistics

Summary statistics for both the consumer and producer survey are presented in the appendix. The average age of consumers is 43 years and half of them are female. Around 30% of the respondents live in households with children; the average household size is 2.5 people. Nearly half of the consumer respondents completed secondary school education and nearly 30% obtained at least a diploma from a technical college. One third of the sample consumes pork once a week, whereas only a minor part (2%) eats pork every day. Over half of the respondents are responsible for the purchase of meat, and 50 percent prefer supermarkets to

discounters, butchers and weekly markets. The majority of respondents prefer to buy fresh pork at the service counter rather than the self-service counters. Thirty-eight percent of the respondents rank taste higher than price, brand and origin. A fifth of the respondents stated that they consume organic food products frequently while roughly 30% never do. Consumers' attitude towards FAW was measured using statements expressing a critical view on livestock husbandry conditions or if they follow the public debate on animal welfare. Furthermore, respondents were asked if the FAW measures described in the choice sets are new to them and how they assess their knowledge of pig farming. On average consumers indicate that they are only partly informed about the presented FAW measures and rather have medium knowledge of animal welfare.

In the farmer survey, the average age of the respondents is 43 years. Nearly 40% hold a university degree and over half a degree from a technical college. Although most of the farmers face unclear succession, they expect on average to continue farming for the next 20 years. The average farm size is 99 hectares, and the fattening capacity is on average 1462 units; relatively high numbers compared to the average German farm[4]. Some respondents (4%) keep dairy or suckler cows, and 9% keep fattening beef and poultry in addition to the pig enterprise. Only a minority of farmers engages in agri-tourism or sells products directly to consumers. A considerable share of farmers sell their fattened pigs to livestock traders or producers' associations on the spot market. Only a few have concluded contractual agreements for selling their pigs. On average, the responding farmers consider the public image of agriculture to be negative. This might be one reason for the overall positive attitude towards animal welfare labels. It may also explain the high share of farmers (65%) who are in principle willing to participate in FAW programmes.

4.2 Estimation results

Table 3 shows the estimation results of the consumer survey. A total of 6200 choice sets were included in the estimation of the consumer model. In 79% of choices, respondents preferred a high-welfare pork cutlet to one produced in accordance with minimum standards. In total, 439

[4] In 2013, only 12% of all pig keeping farms in Germany kept more than 1000 fattening pigs. The average of arable land area per farm in 2013 was 59 hectares (BMELV 2014). The average density of pigs per farm was 1109 heads, including breeding animals. A total number of 11.8 million fattening pigs were kept on 20,500 farms (Destatis 2016).

(57%) consumers always chose a high-welfare pork cutlet, whereas 64 (8%) never chose such a product. The remaining part of 272 (35%) individuals chose only in some situations a high-welfare cutlet.

The upper section of Table 3 presents the coefficients of the FAW programme attributes and the lower section the coefficients of the attitudinal and socio-economic variables. As expected, a higher price premium lowers the likelihood of consumers purchasing high-welfare pork, confirming HC2. The same holds for transport duration. One additional hour of transport time lowers the willingness-to-pay by €0.25 per kilogram pork cutlet. By contrast, and lending support to HC1, all FAW programme requirements designed to enhance animal well-being are positively valued by consumers. Unlike Lagerkvist (2006) and Liljenstolpe (2008), we find that the attribute "no surgery" raises the likelihood of choosing a high-welfare pork cutlet. In the present study, castration and tail docking are subsumed as "surgery". Therefore, the single effect of avoiding castration cannot be identified unanimously. For cutlet from pigs kept on straw bedding, consumers are willing to pay a significant mark-up – between €1.35 and €1.49 per kilogram of meat. Table 3 also reveals relatively high WTP estimates for increased surface area per animal (€2.25 for each additional square meter per pig) and surgery with anaesthesia (€2.70). At first glance, the latter value seems high compared to the corresponding WTP for no surgery (€0.84). The difference may be explained by the perceived risk of boar taint when male piglets are not castrated. Consumers also value manipulable material for pigs.

The effects of consumer characteristics seem to be more subtle. First, female respondents are willing to pay €1.40 per kilogram more than male respondents. Second, consumers who frequently buy pork ('frequency approx.') are more likely to choose high-welfare (WTP of €0.10 per kilogram pork cutlet). As indicated by the negative WTP estimates, individuals with a college degree or higher qualification and those who prefer to buy meat from the butcher and the supermarket, who attach greater importance to price than to brand, origin or taste and who never consume organic products are less likely to buy welfare-enhanced pork cutlets, lending support to HC3 and HC4. In contrast, individuals who regard the current conditions of animal husbandry more critical than the average consumer respondent are willing to pay a premium of €3.00 for a kilogram of high-welfare pork cutlets. Compared to consumers from rural areas, urban consumers are willing to pay roughly €1 per kilogram more for high-

welfare pork. The McFadden pseudo-R^2 of the consumer model is 0.231, indicating a very good model fit according to Louviere et al. (2000).

Table 3: Estimation results from the RPL consumer model

Consumer Model N = 775 Log-Likelihood value: -5057.47 Pseudo-R^2: 0.231		Coefficient	WTP [€/kg]	WTP confidence interval (5%; 95%)
Attributes of the FAW programme ***x***	Constant	0.6088	1.5127	[-1.368; 4.3937]
	Price of pork cutlet	-0.4025***	-	-
	Surface area per animal (m^2)	0.9046***	2.2478	[1.7829; 2.7126]
	Straw bedding (part of barn area)	0.5430***	1.3493	[0.9793; 1.7193]
	Straw bedding (entire barn area)	0.6012***	1.4937	[1.1353; 1.8522]
	Three pieces of manipulable material	0.3196***	0.7942	[0.4264; 1.1620]
	One piece of manipulable material plus material for rooting	0.1913***	0.4754	[0.1382; 0.8127]
	Surgery with anaesthesia	1.0792***	2.6815	[2.2325; 3.1306]
	No surgery	0.3375***	0.8386	[0.4122; 1.2650]
	Duration of transport to abattoir (hrs.)	-0.1025***	-0.2548	[-0.3555; -0.1541]
Socio-economic variables, consumption-related variables and FAW-related variables ***z***	Age	0.0048	0.0120	[-0.0081; 0.0322]
	Gender	0.5539***	1.3763	[0.7095; 2.0432]
	Children	-0.1850	-0.4595	[-2.1863; 1.2671]
	Village	-0.0410	-0.1018	[-1.1545; 0.9508]
	Small town	0.069	0.1714	[-0.6652; 1.0082]
	City	0.4117**	1.0230	[0.1009; 1.9452]
	Secondary school	-0.1009	0.0900	[-0.8391; 1.0191]
	Qualification	0.0362	-0.2507	[-1.0626; 0.5610]
	College degree or higher	-0.3599*	-0.8943	[-1.8176; 0.0289]
	Vocational training	-0.1109	-0.2756	[-0.9760; 0.4247]
	Frequency approx.	0.0394***	0.0981	[0.0439; 0.1522]
	Discounter	-0.6701	-1.6649	[-3.8147; 0.4847]
	Butcher	-0.8744**	-2.1726	[-4.3317; -0.0136]
	Supermarket	-0.8418**	-2.0917	[-4.166; -0.0169]
	Self-service counter	0.1282	0.3187	[-1.1105; 1.7479]
	Fresh meat	0.6607**	1.6418	[0.1341; 3.1494]
	Priority price	-1.0048***	-2.496	[-3.3460; -1.6474]
	Priority brand	0.2468	0.6133	[-0.1359; 1.3627]
	Priority origin	0.0751	0.1866	[-0.5787; 0.9520]
	Keeping conditions = novelty	-0.1130	-0.2809	[-0.9836; 0.4218]
	Critical attitude	1.1988***	2.9788	[2.2946; 3.6630]
	Knowledge about pig farming	-0.0049	-0.0121	[-0.6485; 0.6243]
	Discussion on animal welfare	0.2458*	0.6107	[-0.1040; 1.3254]
	Frequently organic	0.4755**	1.1816	[0.2709; 2.0921]
	Never organic	-1.1039***	-2.7430	[-3.4451; -2.0409]
	Respondent in charge of buying meat	-0.0656	-0.1631	[-0.9183; 0.5920]
	Respondent partly in charge of buying meat	0.3944**	0.980	[0.0354; 1.9247]
	Interaction: Expenditure on food * single household	-0.0270	-0.0671	[-0.4743; 0.3400]
	Interaction: Expenditure on food * two-person household[5]	0.0946*	0.2352	[-0.0123; 0.4828]

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

	Interaction: Expenditure on food * family household (>2 persons)[5]	0.1489*	0.3702	[-0.0590; 0.7994]

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

Table 4 shows the estimation results of the producer survey. Twelve of the 140 pig farmers (9%) always chose a FAW programme, whereas 32 (23%) farmers never chose one of the proposed programmes. The remaining 96 (68%) farmers chose a FAW programme selectively. As expected, a higher mark-up on the producer price has a positive effect on participation, lending support to HP1. Conversely, the requirements to offer pigs additional surface area and bedding straw lower the probability of a FAW programme being chosen, confirming HP2 and HP3. In view of the potentially high costs of modifying existing farm buildings, the relatively high compensation of €1.75 per kilogram of carcass weight for covering the entire barn area with straw appears plausible. Interestingly, the other programme attributes (manipulable material, surgery, and maximum transport times) have no significant effect on choices. Calculations based on data from the Chamber of Agriculture (Landwirtschaftskammer Schleswig-Holstein 2013) show that the requested compensation exceeds the forgone gross margin from reducing stocking density and providing straw bedding.

The lower part of Table 4 reveals the impact of farm and farmer characteristics on choices. Older farmers are *ceteris paribus* more likely to participate in a FAW programme as are farmers with a longer planning horizon (time continuing the farm business in Table 4). Pig farmers who also keep suckler cows (generally perceived as an environmentally friendly, welfare-oriented livestock enterprise) are more likely to choose a FAW programme as are farmers who sell their meat directly to consumers. This lends support to HP4, whereupon the marketing channel and the opportunities to convey a positive image of livestock farming affect the likelihood of accepting a FAW program. Interestingly, farmers with larger pig operations are less likely to participate in a FAW programme. For each additional fattening unit (= one pig place), farmers request an additional compensation of €0.0001 per kilogram carcass weight. This amounts to 1 eurocent per kilogram for an increase in the size of the pig enterprise by 100 pigs. Finally, farmers who are opposed to the introduction of a FAW label must be paid a higher price premium to entice them into a FAW programme.

Table 4 Estimation results from the RPL producer model

Producer Model	Coefficient (SD)	WTA	WTA confidence

N = 140 Log-Likelihood: -708.91532 Pseudo-R^2: 0.358			[€/kg]	interval (2.5%; 97.5%)
Attributes of FAW programme *x*	Constant	-3.8650	1.7522	[-0.8239; 4.3284]
	Price premium	2.2057***	-	-
	Surface area per animal (in m^2)	-2.2075***	1.0008	[0.2304; 1.7712]
	Straw bedding (part of barn area)	-1.9966***	0.9052	[0.2288; 1.5815]
	Straw bedding (entire barn area)	-5.4993***	2.4932	[0.6710; 4.3153]
	Three pieces of manipulable material	0.0941	-0.0426	[-0.2454; 0.1601]
	One piece of manipulable material plus material for rooting	-0.3693	0.1674	[-0.0697; 0.4045]
	Surgery with anaesthesia	-0.2147	0.0973	[-0.1043; 0.2989]
	No surgery	-0.3009	0.1364	[-0.0922; 0.3651]
	Duration of transport to abattoir (hrs.)	-0.0020	0.0009	[-0.0476; 0.0493]
Farm structure variables, attitudinal and socio-economic variables ***z***	Age	0.0752**	-0.0341	[-0.0727; 0.0045]
	High education	-0.2604	0.1181	[-0.1734; 0.4101]
	Basic education	0.5554	-0.2518	[-0.8330; 0.3294]
	Farm acreage	0.0033	-0.0015	[-0.0039; 0.0009]
	Successor	0.2450	-0.1110	[-0.5621; 0.3399]
	Succession is not secured	0.3709	-0.1682	[-0.5768; 0.2405]
	Time remaining farm manager	0.0940***	-0.0426	[-0.0867; 0.0015]
	Fattening units	-0.0003**	0.00015	[-0.00003; 0.0003]
	Dairy cows	0.0056	-0.0025	[-0.6121; 0.6070]
	Keeping suckler cows	0.9177	-0.4160	[-1.1129; 0.2808]
	Cattle fattening	-0.2423	0.1098	[-0.3519; 0.5715]
	Piglet breeding	-0.8988	-0.0291	[-0.3029; 0.2447]
	Pig fattening	0.0642	0.4075	[-0.2001; 1.0151]
	Poultry	0.6258	-0.2837	[-0.7944; 0.2270]
	Tourism	0.8695	-0.3942	[-1.1653; 0.3769]
	Short-term delivery contract	1.0699	-0.4851	[-1.2540; 0.2839]
	Long-term delivery contracts	0.2521	-0.1143	[-0.7002; 0.4717]
	Livestock traders	0.5782	-0.2622	[-0.6955; 0.1712]
	Producer organization	0.4295	-0.1947	[-0.5710; 0.1816]
	Direct marketing	1.6299**	-0.7390	[-1.5875; 0.1096]
	Invest high	0.8567**	-0.3884	[-0.8141; 0.0377]
	Invest low	0.7874**	-0.3570	[-0.7547; 0.0407]
	Image of agriculture	0.1291	-0.0585	[-0.2517; 0.1347]
	Attitude towards animal welfare label	-0.9289***	0.4211	[0.0938; 0.7484]
	Willingness to participate	0.4655	-0.2110	[-0.5867; 0.1647]

Source: own calculation

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

4.3 Comparing WTP and WTA estimates

We now proceed to compare consumers' WTP and farmers' WTA, evaluated at the mean of the respective sample, for individual attributes of a FAW programme. The purpose of this exercise is to test whether consumers' average WTP outweighs producers' average WTA. Since the WTA and WTP estimates are in different units of measurement (€ per kg carcass weight in the producer survey and € per kg pork cutlet in the consumer survey) we convert consumers' WTP into the same unit as the WTA estimates. This conversion requires a number of assumptions. We first assume perfect price transmission. That is, if consumers are willing to pay a premium of, say, ten percent of the reference price (€7/kg), then the producer reference price (€1.70/kg) will, *ceteris paribus*, also rise by ten percent. We further assume that only one third of the pork carcass is marketed as fresh pork. The remaining two thirds are assumed to be sold without price premium as processed meat products or used for producing non-meat products such as gelatine. A final assumption is that the WTP estimates for pork cutlet also apply for other fresh meat parts of the pork carcass. Given these assumptions, we can express consumers' WTP in €/kg carcass weight as follows:

$$(5) \qquad Consumer\ WTP\left(\frac{€}{kg\ carcass}\right) = \frac{1}{3} * \frac{1.70€}{kg} * {WTP_{total}}\Big/{\frac{7€}{kg\ pork}} + \frac{2}{3} * 1.70$$

Table 5 opposes farmers' WTA to consumers' WTP, both denominated in €/kg carcass weight. Farmers' WTA is depicted in the table as "requested producer price", which is calculated by adding to the reference price of €1.70 the WTA for the corresponding FAW attribute. On average, pig farmers demand a price for welfare-enhanced meat that exceeds consumers' average WTP for attributes that had a significant effect. This does not mean, however, that a market for welfare-enhanced pork meat will not emerge.

Table 5: Comparing consumers' WTP and farmers' WTA for welfare-enhanced pork meat

FAW attribute	Requested producer price [€/kg carcass]		Consumers' WTP [€/kg carcass]	Additional WTP for FAW [%]	Maximum consumer price [€/kg cutlet] (WTP_{total})	Consumers' WTP for FAW [€/kg cutlet]
Surface area 1,33 m^2/pig	2.03	>	1.88	11%	7.75	0.75
Surface area 1,66 m^2/pig	2.37	>	2.06	21%	8.50	1.50
Surface area 2,00 m^2/pig	2.70	>	2.25	32%	9.25	2.25
Straw bedding (part of barn area)	2.60	>	2.03	19%	8.35	1.35
Straw bedding (entire barn)	4.19	>	2.06	21%	8.49	1.49
Three pieces of manipulable material	1.65	<	1.88	11%	7.79	0.79
One piece of manipulable material plus material for rooting	1.86	>	1.82	7%	7.47	0.47
Surgery with anaesthesia	1.80	<	2.35	38%	9.68	2.68
No surgery	1.84	<	1.90	12%	7.84	0.84
One hour less of transportation	1.69	<	1.75	3%	7.25	0.25

5. FAW market simulations

We used the results of the econometric models to simulate a market for FAW-enhanced pork meat in Germany. This requires comparison of individual (rather than average) WTP and WTA estimates from which demand and supply curves for welfare-enhanced pork meat can be derived and market shares can be estimated. We carried out such estimations for four alternative specifications of a FAW programme:

- Entry-level FAW programme (programme A): surface area of 1.33m^2 per pig, slatted floor*, one piece of manipulable material*, surgery* and max. 8 hrs of transportation*
- Enhanced FAW programme (programme B): surface area of 1.66m^2 per pig and straw bedding in a part of barn area, 3 pieces of manipulable material and max. 6 hrs of transportation;

- Higher-level FAW programme (programme C): surface area of 2.00m^2 per pig, straw bedding in entire barn area, one piece of manipulable material and rooting material and max. 4 hrs of transportation.

For each of these programmes, we computed individual WTP/WTA values according to Breustedt et al. (2013) as the sum of the WTP/WTA (obtained from expression 4 above) estimates for a programme attribute x and a socio-economic characteristic z_m multiplied by the individual level of the respective variable. For continuous x variables, WTP/WTA estimates are multiplied by the difference between the actual level and the base level of the variable. The base level was always the legal minimum standard. For continuous z variables, the WTP/WTA values are multiplied by the deviation of the individual's value of the variable from the sample mean. Dummy z variables such as gender enter the formula with either one or zero depending on whether the respective characteristic is present or not. Thus:

(6) $$WTP_n \; or \; WTA_n = \sum_{i=1}^{I} WTP_i \;\; or \;\; WTA_i * \Delta x_{ij} + \sum_{m=1}^{M} WTP_m \; or \; WTA_m * \Delta z_{mn}$$

n = individual consumer or producer

z = characteristics of individuals (m= 1, …, M)

x = FAW attribute levels (i = 1, …, I)

j = FAW programme (entry-level, enhanced, higher-level)

As a result, we obtained for each pig farmer an individual WTA for each of the three FAW programmes under investigation. Likewise, we computed for each consumer respondent an individual WTP for a pork cutlet produced in accordance with each of the three FAW programmes. We applied expression (5) to convert the consumers' WTP estimates to WTP per kilogram of carcass weight. We sorted the WTP estimates in descending order and the WTA estimates in ascending order to plot supply and demand curves for the three distinct FAW programmes. The simulations make the implicit assumption that price increments for welfare-enhanced pork meat do not affect the quantity demanded by consumers.

To simulate the domestic market for pork produced in accordance with the defined FAW programmes, we had to extrapolate the quantities of supply and demand of the sample to the entire German market. The sample farms represent a capacity of 204,713 fattening places in total (1462 on average).[6] Assuming on average 2.89 fattening cycles per year and a carcass

[6] The average pig fattening unit in Germany has 574 fattening places (Destatis: Statistisches Bundesamt 2016).

weight of 95 kg, our sample farms produce an estimated 18.7 million kilograms of fresh pork meat[7]. Given an annual consumption of 672.2 million kilograms of fresh pork in Germany in 2015 (AMI 2016), our sample farms meet 2.78% of domestic demand. Neglecting foreign trade activities, the quantity produced by each of our sample farmers was therefore multiplied by 35.9 (the reciprocal of 2.78%) to approximate total production. A similar approach was applied to the consumer sample. We used the information on consumption frequency per month[8] to calculate for each household the days per year when pork meat was consumed (90 consumption days on average). Taking into account the annual average consumption of pork of 8.2 kilograms per capita[9], a quantity of 0.09 kilograms pork per capita per day was derived. Multiplying this quantity by the number of household members and consumption days per year yields a total annual consumption of 15,056 kilograms of pork meat for the whole sample of consumers. This represents around 0.0022405% of total fresh pork consumption in Germany. To extrapolate this figure to the entire German market, we scaled the consumption quantities of pork (kg) for each household by a factor of 44633 (the reciprocal of 0.0022405%).

[7] 204,713 fattening places*2.89 cycles*95 kilograms*0.33 share of fresh meat = 18.7 million kilograms fresh pork meat.

[8] The frequency of meat consumption was surveyed in four categories (see table 4). We approximated for each category a number of days per month: seldom = 1 day per month; 2-3 days/month = 2 days/month; once a week = 4 days/month; several days a week = 12 days/month; daily = 20 days/month.

[9] A quantity of 672.2 million kilogram pork eaten by the German population (81.9 Million people), results in an average consumption quantity of 8.2 kilograms per capita per year.

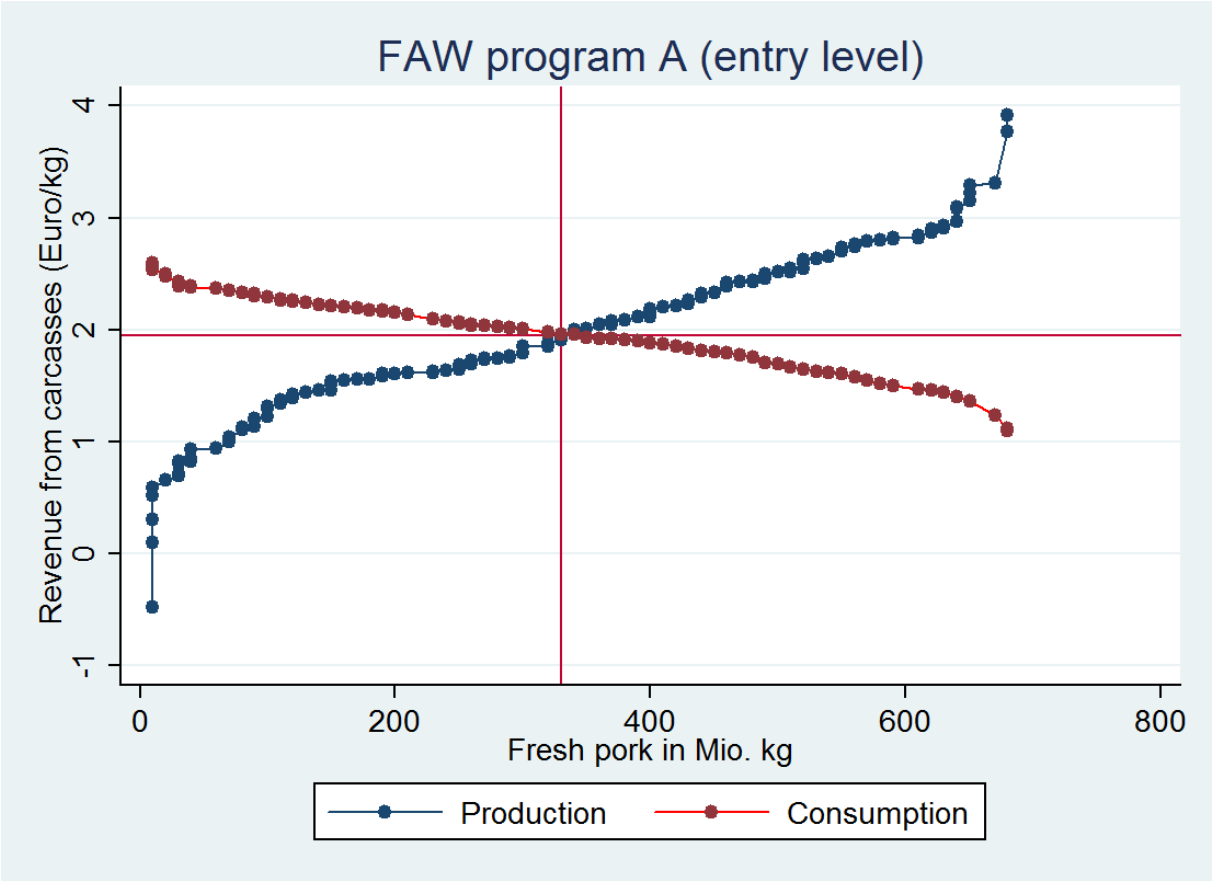

Figure 1: Supply and demand estimations for fresh pork meat produced in accordance with FAW programme A (entry-level)

Figure 1 plots WTA and WTP estimates based on expression (6) for the entry-level FAW programme scaled to the entire German fresh pork market. Demand and supply of thus produced pork meat would balance at a quantity of 330 million kilograms, representing a 49% share of Germany's pork meat consumption, and a price of €1.95 per kilogram. The equilibrium price is just €0.25 above the reference price of €1.70 per kilogram. Interestingly, some farmers stated that they would be willing to join the entry-level FAW programme at a price below the reference price.

In addition to increased surface space per pig, the enhanced FAW programme B requires bedding straw in part of the barn, three pieces of manipulable material and a maximum of six hours of transportation. It can be observed from Figure 2 that market equilibrium would be reached at 110 million kilograms, which accounts for 16% of total consumption, and a price of €2.54 per kilogram carcass weight.

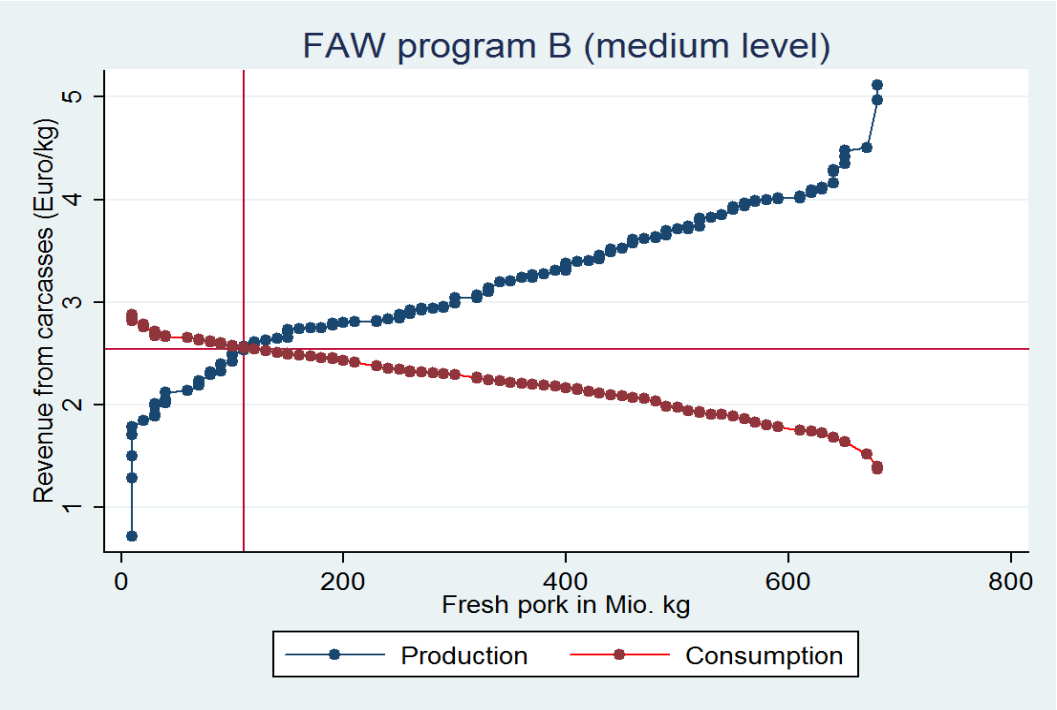

Figure 2: Supply and demand estimations for fresh pork meat produced in accordance with enhanced FAW programme B

Results for the higher-level FAW programme C are depicted in Figure 3. This programme requires a surface area of 2.00m^2 per pig, straw bedding in entire barn area, one piece of manipulable material and rooting material and a maximum of 4 hours of transportation. For a programme of this type, the market would balance at 10 million kilograms of pork meat and a price of € 2.86 Euro per kilogram.

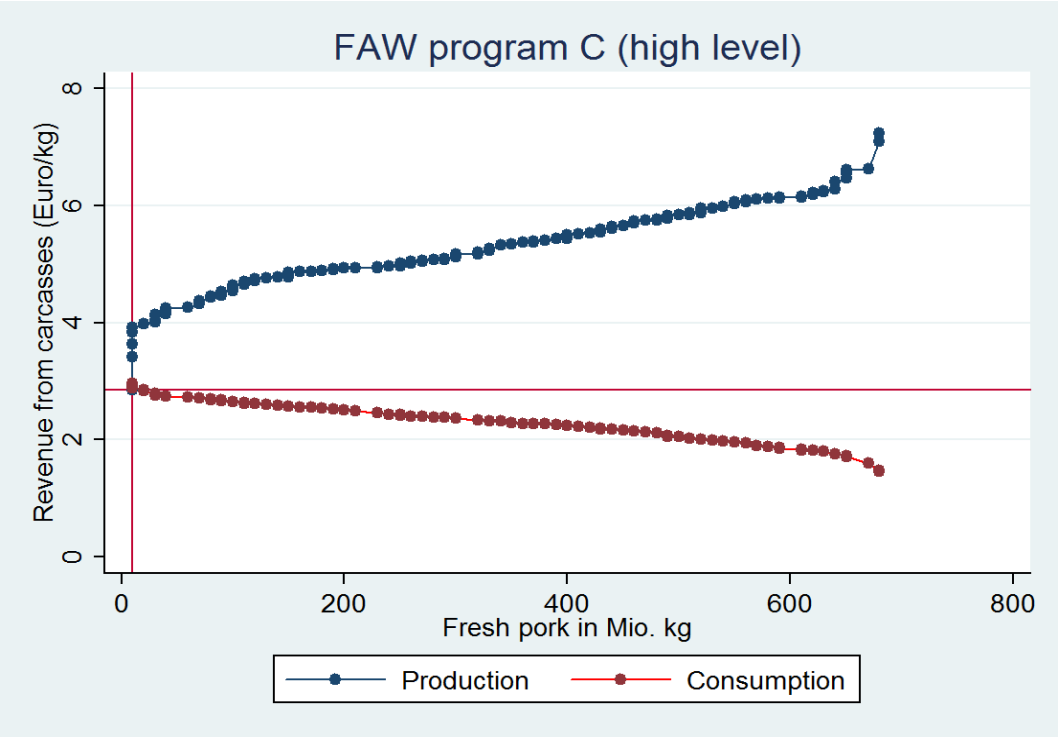

Figure 3: Supply and demand estimations for fresh pork meat produced in accordance with higher-level FAW programme C

Producers require a price ranging from €2.84 to €7.24 per kg carcass weight, whereas maximum prices derived from consumers' WTP lie between €1.40 and €2.60 per kilogram carcass.

6 Discussion and Conclusion

This paper contributes to the literature by combining demand and supply side estimations for welfare-enhanced pork using nearly identical choice sets for both pig farmers and pork consumers. We used the results of the RPL model to estimate consumer WTP and producer WTA and simulate a market for pork produced under alternative FAW programmes. We found that estimates of consumers' WTP for all FAW attributes considered are all significantly positive. Previous consumer studies had similar results (Lagerkvist et al., 2006). We estimate a WTP of 39% of the reference price for pig castration under anaesthesia (compared to castration without anaesthesia), indicating that this FAW attribute is highly valued by consumers. Exactly the same figure was found by Liljenstolpe (2008). In contrast to the present study, Lagerkvist et al. (2006) report that females are WTP less than men for using

straw as bedding material, for providing access to outside air and for more animal-friendly forms of sow fixation. An opposite effect was found in the present study.

On the producer side, our model revealed positive estimates of WTA only for surface area per pig and the amount of bedding material on offer, but not for the other attributes of our stylised FAW programme. This is not surprising since offering more space per animal and straw as bedding material are very costly constraints for the majority of pig producers, whereas prescriptions regarding surgical interventions, manipulable material and transportation times are more easily taken on board. Comparing the results of the producer model to existing studies is difficult because they are either focused on general attitudes towards such programmes (Bock and van Huik 2007; Kirchner et al. 2014) or investigate other choice attributes than the ones considered in the present study (Roe et al. 2004, Norwood et al. 2006, Schulz and Tonsor 2010).

The present study has revealed that farmers who are generally willing to accept a FAW programme require on average a price increment above what consumers are willing to pay. To account for differences among respondents, individual WTP and WTA estimates were derived. The market simulation based on these values showed a more differentiated picture of supply and demand relationships for pork produced under four distinct stylised animal welfare programmes. Standards that are only slightly above the QS minimum standard (represented by entry-level FAW programme A) are well accepted by both consumers and producers and have the potential to capture a market share of up to 49%. Programmes that are more restrictive on stocking density, duration of transportation and that require straw as bedding material as well as manipulative material are estimated to gain much smaller market shares. This development can be explained by an increasing divergence between what farmers request for implementing higher FAW standards and what consumers are willing to pay. We wish to emphasise that our market simulations were made under restrictive assumptions regarding the extrapolation of estimation results to the German pork market. The reader is also reminded that the empirical analysis in this paper is based on two samples that are not representative of the entire population. This means that the conclusions drawn are tentative and must be interpreted with caution.

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Appendix

1. Summary statistics of consumer respondents

N = 775		
Variable	Mean (SD)	Explanation
Age	43 (17.2)	Age of respondent
Gender	48% (50%)	Dummy: 1= respondent is female
HH size	2.5 (1.2)	Number of household members, incl. children
Children	28% (44%)	Households with children
Village	11% (31%)	Dummy: 1= Community with less than 500 people
Small town	40% (49%)	Dummy: 1= Town with 5,000 and 20,000 people
City	29% (45%)	Dummy: 1= City with more than 100,000 people
Secondary school	46% (50%)	Dummy: 1= Respondents who have secondary school leaving certificate
Qualification	20% (40%)	Dummy: 1= Respondents have qualification for university entrance.
College degree or higher	18% (38%)	Dummy: 1= Respondents have a college degree.
Vocational training	29% (45%)	Dummy: 1 = Respondent completed a vocational training
Frequency approx.	7.5 (6.4)	Pork consumption in days per month
Frequency	1.6% (13%) 28% (45%) 33% (47%) 22% (42%) 15% (35%)	Frequency of pork consumption: 1-4; 1= daily; 2= several times a week; 3= once a week; 4= 2-3 days a month; 5= more seldom
Discounter	17% (38%)	Dummy: 1= Pork purchase mainly in discounter
Butcher	25% (43%)	Dummy: 1= Pork purchase mainly at the butcher's
Supermarket	55% (50%)	Dummy: 1= Pork purchase mainly in supermarket
Self-service counter	36% (48%)	Dummy: 1= Mainly purchase of pork from the self - service counter
Fresh meat	60% (49%)	Dummy: 1= Mainly purchase of fresh pork
Priority price	47% (50%)	Dummy: 1= Purchaser considers price as very important.
Priority brand	34% (47%)	Dummy: 1= Purchaser considers brand as very important.
Priority origin	42% (49%)	Dummy: 1= Purchaser considers origin as very important.
Keeping conditions = novelty	34% (47%)	Dummy: 1= The presented keeping conditions are new to the consumer.
Critical attitude	54% (50%)	Dummy: 1= The consumer is critical towards the conditions the animals are kept nowadays.
Knowledge about pig farming	27% (44%)	Dummy: 1= The consumer is not well informed about pig farming.
Discussion on animal welfare	31% (46%)	Dummy: 1= Consumer is following the public debate on animal welfare.
Frequently organic	22% (42%)	Dummy: 1= Respondent often purchases organic pork
Never organic	29% (45%)	Dummy: 1= Respondent never purchases organic pork
Respondent purchases meat	52% (50%)	Dummy: 1= Over 50 percent of pork purchase is done by the respondent exclusively
Respondent does the purchase of meat partly	18% (39%)	Dummy: 1= The purchase of pork is equally shared with another household member

2. Summary statistics of farmer respondents

N = 140

Variable	Mean (SD)	Explanation
Age	43.4 (11.3)	Farmer's age
High education	37% (48%)	Dummy: 1= Farmer has a university degree or PhD
Basic education	6% (25%)	Dummy: 1= Farmer has vocational training
Farm acreage	99 (68.2)	Hectares of arable land on farm
Successor	31% (47%)	Dummy: 1= Yes, succession is secured
Succession is not secured	54% (50%)	Dummy: 1= No, succession is not secured yet
Time remaining farm manager	21 (10.8)	Years planned to remain farm manager
Fattening units	1462 (1161)	Number of fattening units on farm
Dairy cows	4% (20%)	Dummy: 1= Dairy cows
Keeping suckler cows	4% (19%)	Dummy: 1= Keeping suckler cows
Cattle fattening	9% (28%)	Dummy: 1= Cattle fattening
Piglet breeding	40% (49%)	Dummy: 1= Piglets breeding
Pig fattening	93% (26%)	Dummy: 1= Pig fattening
Poultry	9% (29%)	Dummy: 1= Poultry keeping
Tourism	3% (17%)	Dummy: 1= Farm offers agri-tourism
Marketing of pigs		
Livestock traders	57% (50%)	Dummy: 1= Pigs are sold to livestock traders
Short-term delivery contract	6% (23%)	Dummy: 1= Short-term delivery contract
Long-term delivery contracts	9% (28%)	Dummy: 1= Long-term delivery contracts
Producer organization	36% (48%)	Dummy: 1= Sales by producer organization
Direct marketing	4% (20%)	Dummy: 1= Meat is sold directly to consumer
Invest high	31% (46%)	Dummy: 1= Willingness to invest in pig enterprise is high
Invest low	40% (49%)	Dummy: 1= Willingness to invest in pig enterprise is low
Image of agriculture	4 (0.8)	Item: How would you assess the public image of agriculture? 1-5; 1= very positive; 5 = very negative
Attitude towards animal welfare label	2.8 (1.3)	Item: What do you think about the introduction of an animal welfare label for pigs? 1-5; 1= strongly like it; 5= strongly dislike it
Willingness to participate	65% (48%)	Dummy: 1= farmer is willing to participate in a FAW program if arising costs are covered.