Are German farmers ready for ‘warm restructuring’ of the pig sector?

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Abstract

Recent statutory changes have increased the pressure on the German livestock sector to adapt. This paper aimed to ascertain whether German pig farmers would be willing to join a pig farming exit scheme similar to the Dutch ‘warm restructuring’ programme. The analysis was based on a discrete choice experiment with 346 pig farmers. The results indicated great interest of the respondents in a government-run decommissioning scheme. Differences in the perception of scheme attributes (compensation offered, demolition requirements, restrictions on future barn construction and slurry intake) and uncertainty among participants were highlighted by the results of a scale-adjusted latent-class estimation.

Key Words: Livestock decommissioning scheme, farm exits, structural change, scale-adjusted latent class model

1 Introduction

Recent changes of the legislative framework regulating animal welfare and environmental impacts of livestock farming in Germany have increased the pressure on the sector to adapt. In particular, the 2020 amendment of the German Fertiliser Ordinance (*Düngeverordnung*) and the latest revision of the Livestock Husbandry Ordinance (*Tierschutz-Nutztierhaltungsverordnung*) present considerable challenges for pig farmers. The new legal requirements make costly adjustments necessary, especially for smaller farms, and these extra costs cannot be recouped in a meat sector characterised by cost leadership (WBAE, 2015). The situation for German pig farmers is exacerbated by the current pig market crisis which originated from the outbreak of African Swine Fever in September 2020. The tense situation has led to calls for emergency aid from the government. One option for the government to help the sector is state-subsidised decommissioning of pig farming facilities. The Dutch concept of ‘warm restructuring’ is an example of this policy (Wissenschaftliche Dienste des Deutschen Bundestages, 2019).

The present paper aims to establish whether German pig farmers would be interested in an exit scheme if it were available in Germany. It examines how the design of a potential state-run exit scheme would affect pig farmers’ willingness to participate. Specifically, we wish to establish how farmers would respond to the requirement to demolish existing pig barns, how they assess bans on re-investing in the pig enterprise or limitations on future slurry intake from other farms. Furthermore, we investigate how pig farmers would respond to softer versions of these requirements, e.g. limiting re-investments to barns with enhanced animal welfare.

To this end, we conducted an online survey with 346 German pig farmers in the summer of 2020. The respondents were asked in a discrete choice experiment to choose among alternative exit schemes and the option not to participate. The data were analysed using a scale-adjusted latent class model. Compared to the standard model, the scale-adjusted model allows revealing respondents' uncertainty in decision making.

Discrete choice experiments (DCE) have been widely applied to elicit stakeholders' preferences for the design of contracts in agriculture. In the field of livestock production, DCEs have been used to analyse contracts for a more animal or environmentally friendly production (i.e. Schreiner and Hess, 2017; Danne and Musshoff, 2017; Latacz-Lohmann and Schreiner, 2019; Peden *et al.*, 2019) and the production of GMO-free milk (Schreiner and Latacz-Lohmann, 2015). None of the cited studies have applied the scale-adjusted estimation model to reveal respondents' uncertainty in making decisions. We wish to demonstrate that the scale-adjusted latent-class model used to analyse our discrete choice data can yield valuable information for the effective design of a pig exit scheme prior to its launch. Besides assessing how the design of such a scheme affects farmers' willingness to participate, the extended model revealed preference heterogeneity among decision-makers as well as uncertainty among the participants in making choices. Furthermore, the paper investigates which farmers would lend themselves to being a suitable target group for 'warm restructuring' of German pig farming.

The next section outlines recent developments of the German pig farming sector, explains the concept of 'warm restructuring' and possible reasons behind decisions to exit livestock farming. Section 3 describes the methodology, the design of the questionnaire and the conduct of the survey. Section 4 presents the results. The final Section 5 critically discusses the findings, places them in the existing literature and draws conclusions for the effective design of a potential pig farming exit scheme in Germany.

2 Structural change in pig farming and the Dutch 'warm restructuring' scheme

In 2019 Germany was among the world's largest exporters of pig meat (Rohlmann *et al.*, 2020). However, intense price competition in international markets has necessitated cost leadership in the production of bulk commodities. German pig farms have responded to this challenge by growing in size (Efken *et al.*, 2015), and a distinct structural change has become evident (WBAE, 2015; Windhorst and Bäurle, 2011). The number of farms has plummeted since farmers with small sow herds in particular decided to cease production. The number of pig fattening farms fell by 20 % between 2014 and 2019, in the same period 27 % of piglet producers ceased operating (Rohlmann *et al.*, 2020). However, fattening pigs numbers have only been declining by 6 % during the same time period (Windhorst and Bäurle, 2011; Rohlmann *et al.*, 2020).

Structural change was accompanied by a massive concentration of pig production in the western part of Lower Saxony and the northern part of North Rhine-Westphalia (Rohlmann *et al.*, 2020). This has led to a range of environmental and societal issues and, consequently, society's acceptance of livestock farming has plummeted in the last few decades (Inken *et al.*, 2018). The political response has been to tighten the regulatory framework for more sustainable livestock farming, for example by banning non-curative interventions, tightening the rules for spreading animal manure, and imposing stricter animal welfare standards through yet another amendment to the Livestock Farming Ordinance.

Pig farming in the Netherlands has also been undergoing continuous structural change, particularly between 2006 and 2011. After a slight initial drop in stocking rates, herds were restocked and peaked in 2015 (Hoste, 2017), but pig populations have been falling ever since (Statista, 2020). As in Germany, Dutch citizens are demanding higher animal welfare standards, protection of animal health, reduction in odour nuisance, particulates and pollution, and greater transparency (Wissenschaftliche Dienste des Deutschen Bundestages, 2019). To ensure farmers are not needlessly hard hit, the Dutch government provided subsidies within the scope of its so-called 'warm restructuring of pig farming' ('warme sanering varkenshouderij') (Wissenschaftliche Dienste des Deutschen Bundestages, 2019).

In addition to providing support for structural adjustments, as also intended by the German Ministry of Food and Agriculture (BMEL, 2020), the Netherlands provide government support for the closure of a farm's pig production enterprise (Government of The Netherlands, 2020a, 2020b). The Dutch exit scheme is designed to allow farms to cease pig production efficiently and responsibly (Government of The Netherlands, 2020b). It is particularly addressed at farms in provinces with high stocking rates (Noord-Brabant, Limburg, Gelderland, Overijssel and Utrecht) and includes a buyout of some of the production quotas which were introduced in 1998. Participation in the scheme involves demolition of decommissioned pig barns and a ban on future pig farming in the same location (Government of The Netherlands, 2020a, 2020b). In return, farms receive individual market-based compensation for their production quotas and for the capital loss of their barns (Colenbrander, 2018). In the end, 407 farms with around 10.5 % of the Dutch production quotas took part in the scheme (Grabmeier, 2020).

3 Theoretical background

3.1 Experiment design and underlying hypotheses

To assess the preferences of German pig farmers for the design of a potential decommissioning scheme, we conducted a discrete choice experiment. Table 1 shows the variations of five attributes chosen for the stylized support scheme: the amount of compensation on offer, rules on demolition of decommissioned pig barns, constraints regarding future building projects, restrictions on organic fertiliser intake from other farms, and mode of payment. In the choice sets used, the compensation payments for sow places were shown to pig fatteners only if they operated a closed system.

Table 1: Attributes of a stylised pig fattening exit scheme. The attribute levels for non-participation are shown in bold font

Attribute	Attribute levels
Compensation payment in € per sow place and year	**€ 0.00,** € 120.00, € 140.00, € 160.00, € 180.00
Compensation payment in € per fattening pig place and year	**€ 0.00,** € 12.50, € 15.00, € 17.50, € 20.00
Demolition	**Not required,** required, required with costs of demolition reimbursed
Barn construction	**Allowed without restrictions,** barns improving animal welfare only, ban on barn construction
Slurry intake from other farms	**Allowed without restrictions,** at existing level, not permitted at all
Mode of payment	**No payment,** one-off payment, annual payment

(Source: own illustration)

In the choice sets, the level of the compensation payment was given in euros per sow place and fattening pig place for each year of its remaining life. The level of payment offered was based on the barn's calculated capitalised earnings value, calculated using the gross margin from the Schleswig-Holstein specialist pig consultancy service and direct costs from the KTBL (Schweinespezialberatung Schleswig-Holstein, 2010-2018; KTBL, 2014). It was assumed that farmers' acceptance grows with an increase in the amount of compensation on offer.

The second attribute varied in relation to the potential demolition of the barn: demolition at farmers' own expense, demolition with costs reimbursed or demolition not required. It was assumed that the obligation to demolish at the farmers' own expense in particular would be evaluated negatively since it diminishes the financial benefit of participating in the scheme. Whether demolition but with costs reimbursed was also viewed negatively would depend on their evaluation of subsequent possible uses.

The third attribute concerned restrictions on future re-investment in pig farming. This attribute ranged from no restrictions (barn building permitted) through re-investments being limited to buildings with higher animal welfare standards (for simplicity with half occupancy), to a complete ban on erecting new pig barns. The last level was expected to have a very negative influence on scheme acceptance. When only animal welfare barns are permitted, this would potentially be evaluated less negatively as schemes already exist to fund these kinds of barns.

The fourth attribute related to the intake of slurry from other farms. In some choice sets, this was permitted without any restrictions, in others it was limited to the current level or was completely prohibited. It was assumed that restriction at the current level would either be evaluated negatively or, at best, tolerated. A negative evaluation would be because farmers in regions with high stocking rates are often paid for accepting slurry from other farms. Furthermore, farmers potentially value the positive impact of organic fertiliser on soil life and would not want to give this up.

The final attribute used in the choice sets related to the mode of payment. In some choice sets, a one-off capitalised compensation payment was offered. Another option was an annual payment for the remaining life of the barn. Different preferences are conceivable as a one-off payment could be more attractive to farmers interested in investing in other projects. By contrast, an annual payment could be more attractive due to potentially lower taxation.

To ascertain the influence of known structural change factors on exit decisions, the questionnaire also featured questions about personal and farm characteristics. Existing studies on structural change demonstrated the positive impact of age and lack of a farm successor on exit decisions (Weiss, 1999; Dong, Hennessy and Jensen, 2010; Pietola and Väre, 2003).In the past, farmers with a higher level of education have also shown greater probabilities of leaving farming (Dong *et al.*, 2010; Boehlje, 1992). In relation to the farms characteristics, it was assumed that farmers with larger pig farms would be less willing to participate and give up their pig enterprise (Thiermann *et al.,* 2019). If farmers have old barns, it was presumed that they would be more willing to give these up. They may have problems meeting quality standards and face a poorer level of performance (Dong *et al.*, 2010). If there are links with other business segments, such as photovoltaic installations on roofs or digestion of liquid fertiliser in biogas installations, a negative influence on acceptance of the scheme was expected. This was also assumed if farms operate in a closed or partially closed system. In relation to a farms' financial success, it was assumed that farms belonging to the top 25 % of the sector would not participate in the schemes.[1] Studies have established that efficient farms in particular prefer not to exit (Foltz, 2004; Thiermann *et al.*, 2019).

To take account of the increasing pressure applied by changes in the law, this study also examined whether operational problems in the past influence the exit decision. The Fertilizer Ordinance (2017) defined a maximum nitrogen surplus of 60 kg N/ha and the provision on

[1] When farmers participate in industry comparisons, they are usually classified in the top 25 %, middle 50% or bottom 25 % of their peer group.

adequate storage space (Fertiliser Ordinance, 2017). Both could lead to greater acceptance of schemes due to the high costs of purchasing or renting additional land for slurry disposal or the need to export slurry to regions with lower livestock densities.

The survey was conducted using the online platform Unipark. In the survey, each participant was given three different versions of the stylized exit scheme, and the option of non-participation. Each questionnaire included eight choice sets that were randomly assigned to participants. The design was created using the software-package decreate in Stata and had a D-efficiency of 92.93 %. In total 32 choice cards were generated, an example is shown in the appendix. The accuracy and comprehensibility of the information on the choice cards were checked by submitting the questionnaire to pre-testing by scientific staff, members of a farmers' associations and pig farmers themselves. Participation in the survey was predominantly advertised online. Farmers had between June and mid-September 2020 to complete the survey.

3.2 Behavioural model to explain the decision to participate

The underlying assumptions of discrete choice experiments are explained in Hensher *et al.* (2018) and are briefly reiterated here. Overall, it is assumed that a decision maker *n* selects alternative *i* in choice situation *c* if outcome *i* provides the highest utility. Therefore, a participant in the survey will choose a stylised support scheme *i* if it provides him or her with a higher utility than the other schemes offered or the status quo (no participation). The utility (U_{nci}) of each alternative in the experiment can be divided into an observable part (V_{nci}) and a non-observable part (ε_{nci}):

$$P_n(i) = Prob\ (V_{nci} + \varepsilon_{nci} > V_{ncj} + \varepsilon_{ncj},\ \forall\ \ i, i \neq j) \tag{1}$$

The observable part of utility is assumed to be a linear function of the attributes and their observed levels (x_{nci}). The estimated coefficients β represent the marginal utility of an attribute for respondent *n*:

$$U_{nci} = \lambda_n \beta_n x_{nci} + \varepsilon_{nci} \tag{2}$$

In equation (2), heterogeneity in scale is considered, with λ_n being a positive scale factor, taking values between 0 and 1. The variance of ε_{nci} is inversely related to the scale factor. Therefore, a smaller scale factor indicates greater uncertainty of the respondents in making choices (Hensher *et al.*, 2018).

(Scale-adjusted) latent class models assume a discrete rather than a continuous distribution of preferences and scale factors among the respondents. It is assumed that the preference structure within the (latent) preference classes is homogeneous, therefore subgroup-specific coefficients are estimated. The model estimates the probability *P* that an observation *n* is assigned to a certain class *s* *(s=1…S)*. This probability depends on respondent-specific covariates *(h_n.)*, their influence is indicated by δ_s:

$$P_{ns|d} = \frac{exp(\delta_s h_n)}{\sum_{s=1}^{S} exp\ (\delta_s h_n)} \tag{3}$$

The scale factors are assumed to be homogenous for the members of the same scale class *d* (*d=1…D*). Scale class membership also depends on respondent-specific covariates (h_n), their influence is described by γ_d:

$$P_{n|d} = \frac{exp\ (\gamma_d h_n)}{\sum_{d=1}^{D} exp\ (\gamma_d h_n)} \tag{4}$$

In the end, the probability *P* that respondent *n* selects alternative *i* in choice situation *c* is estimated under consideration of class membership and scale factors:

$$P_{nci|s,d} = \frac{exp(\lambda_d \beta_s x_{nci})}{\sum_j\ exp\ (\lambda_d \beta_s x_{ncj})} \tag{5}$$

The scale-adjusted latent class model was estimated and described as proposed by Vermunt and Magidson (2005). The advantage of scale-adjusted models is that they deliver information about the true values of the coefficients. Standard models such as conditional logit estimate the values β_{CL}, but these are equal to $\beta_{CL} = \lambda\beta$. Therefore scale-adjusted models are expected to deliver more accurate parameters, otherwise it remains unclear whether difference in preference weights are due to utility differences or choice uncertainty (Nguyen *et al.,* 2018; Davis *et al*., 2016).

In addition to the coefficients willingness-to-accept (WTA) were estimated. WTA is calculated as the ratio of the coefficients of an attribute of interest and the price variable, in our case the compensation offered (Hensher *et al.*, 2018):

$$WTA = -\frac{ß_{attribute}}{ß_{cost\ share}} \tag{6}$$

4 Results

4.1 Descriptive statistics

A total of 346 farmers took part in the survey, who were either specialised in fattening pigs or operated a closed system. Of the producers surveyed, around 49 % farmed in the stronghold of pig farming in northwest Germany (postcode areas 26, 49, 48, 27, 33, 32, 59). The average respondent was 45 years old and the majority of respondents (72 %) had specialist agricultural training. The average respondent farmed around 57 hectares of arable and grassland. The vast majority of farms (89 %) were run full-time (main occupation). On average 1,588 fattening pigs were kept per farm. Farmers operating a closed system kept around 93 sows in addition.

Table 2: Descriptive statistics of participants (n=346).

Variable	Mean (std. dev.)	Description
Age	44.86 (11.48)	Participant's age in years
Farming training	0.72 (0.45)	Participant has had agricultural training (apprenticeship, master farmer, vocational school, university degree) (dummy)
Main occupation	0.89 (0.32)	Farming is the main occupation (dummy)
Sow places (100 head)	0.93 (2.15)	Sow places on the farm
Fattening pig places (100 head)	15.88 (17.57)	Fattening pig places on the farm
Closed system	0.37 (0.48)	Farm has sows and fattening pigs in a (partially) closed system (dummy)
Leased	0.05 (0.22)	Pig barns are not operated by the participant, but leased to other farmers (dummy)
Commercial livestock farming	0.25 (0.44)	Alongside agricultural activities, there is also commercial livestock farming (dummy)
Top 25 farms	0.41 (0.49)	Farm is in the top 25 % of farms in a financial performance ranking (dummy)
Utilised agricultural area (100 ha)	0.57 (2.12)	Cultivated arable and grassland in hectares (UAA)
Dairy cow places (100 head)	0.18 (2.10)	Dairy cow places on the farm
Poultry places (100 head)	37.90 (205.59)	Poultry places on the farm
Biogas	0.23 (0.42)	Farm digests slurry in a biogas installation (dummy)
Storage	0.40 (0.49)	Farm has had to or has to invest in storage within the scope of the amendment of the Fertiliser Ordinance 2017 (dummy)
Nitrogen balance	0.16 (0.37)	Farm had problems in the past maintaining the balance of 60 kg N/ha (dummy)
Photovoltaics	0.69 (0.46)	Photovoltaic installations on pig barn roofs (Dummy)
Farm closure	0.12 (0.33)	Farm will close in the next 10 years (dummy)
Farm succession	0.41 (0.49)	Farm succession is secure (dummy)
North-West	0.49 (0.50)	Farm is located in the North West of Germany (an area of intensive livestock farming)

(Source: own calculation)

4.2 Results of the scale-adjusted latent class estimations

The estimation was carried out with the statistical software *Latent Gold 6.0*. The final model was chosen by the BIC-criterion (Table 3).

Table 3. BIC-values of the estimated models.

	Log-Likelihood	BIC
2 Preference Classes	-2,779.141	5,727.829
3 Preference Classes	-2,664.078	5,614.631
4 Preference Classes	-2,596.538	5,596.481
2 Preference Classes 2 Scale Classes	-2,710.766	5,614,465
3 Preference Classes 2 Scale Classes	-2,622.197	5,554.255
4 Preference Classes 2 Scale Classes	-2,576.967	5,580.723

(Source: own calculation)

According to the BIC values, the scale-adjusted latent class model SALC with three preference and two scale classes provides the best fit with the data, indicating that accounting for both taste and scale heterogeneity has improved the accuracy of preference estimates (Louviere and Eagle 2006).

The chosen model is presented in Table 4.[2] Overall, respondents in the first preference class showed a high probability of joining a support scheme. However, the respondents in the second scale class are less certain about their perception of the attributes. Therefore, the choice probability was 97 % for the first and 84 % for the second scale class.[3] The level of compensation on offer was crucial for them, and they rejected demolition without costs being reimbursed. However, they would welcome demolition if the costs were reimbursed. Furthermore, they would reject an import ban of slurry and even a restriction of slurry intake to the current level. The significantly negative estimators for the ban on building barns in the future or being limited to building animal welfare barns only indicate that they would like to continue to invest in pig farming.

In comparison, respondents in the second preference class were negative about the scheme, demonstrating a low probability of participation at 2 % for the first scale class. Farmers in the second scale class are less certain about this negative perception, and the probability of choosing a support program was 31 %. Compared with the first preference class, they would accept softer requirements. They accepted the restriction to limit slurry intake to the current level and to be only allowed to build animal welfare barns in the future. A complete ban on building or slurry intake was also rejected. The significant effects of the mode of payment highlight how strongly the respondents belonging to the second preference class were rejecting the exit scheme in general.

Respondents belonging to the third preference class welcomed the scheme. For them, the compensation payment and possibility of investing further in the pig enterprise appeared less important. They rejected stipulations on the intake of livestock manure and demolition of buildings. The coefficients of attributes for barn construction and the obligations to demolish suggest that they assessed alternative subsequent use of the barns positively. Their probability to choose a support scheme was 63 % for the first scale class and 58 % for the second scale class.

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[2] The personal and farm characteristics considered were determined using a likelihood ratio test and mixed logit estimation. The procedure revealed that the variables ‘Biogas production’, ‘Pig fattening places’, ‘Sow places’, ’Dairy places’, ‘Poultry places’, ‘Nitrogen balance’, ‘Storage capacity’ can be excluded from the model.

[3] The scale factor is inversely related to the variance of the error terms. The smaller the scale factor, the more dispersed the errors. The random part of utility thus becomes larger relative to the deterministic component and choices are likely to be more random (i.e. choice probabilities tend to become more equal across alternatives). In other words, the model is less able to predict deterministically the alternative with the highest utility when the scale factor is smaller.

Personal and farm characteristics were also included to explain preference class and scale class membership. The first preference class was chosen as the reference for the other two classes to explain latent class membership. The socioeconomic characteristics showed that older farmers and part-time farmers were affiliated more with the third class, welcoming the scheme. This could explain why they did not appear to have plans for further investment in pig farming. Respondents belonging to the second preference class had photovoltaics on the roof of their barns and a closed system. Furthermore, they tended to belong to the top 25 % of pig farmers even though the effect just misses a level of significance.

Respondents belonging to the first preference class, who welcomed demolition when costs are reimbursed and who seemed to be interested in future investments in pig fattening, had lower probabilities of having photovoltaics on the roof of their barns than members of the second preference class. Furthermore, they were younger than respondents belonging to the third preference class. This could explain their less critical attitude towards demolition in return for cost reimbursement and why they seem to be interested to invest in pig production in the future.

Table 4. Factors affecting farmers' decisions to participate in a pig fattening decommissioning scheme. Results from the scale-adjusted latent class model

	3 preference and 2 scale class models[a]					
Preference Class	**Class 1**		**Class 2**		**Class 3**	
	Coef.	**p-value**	**Coef.**	**p-value**	**Coef.**	**p-value**
Compensation payment in €/ pig fattening place	0.187***	0.000	0.805***	0.001	0.098	0.360
Demolition required	-0.550***	0.000	-2.512**	0.031	-8.273***	0.000
Demolition required with costs reimbursed	0.315***	0.004	0.146	0.84	-13.948**	0.054
Barn construction (enhanced animal welfare)	-0.197*	0.071	0.228	0.750	-0.288	0.65
Ban on barn construction	-0.185*	0.099	-1.730*	0.058	-0.416	0.540
Slurry import at existing level	-0.222**	0.034	-0.387	0.640	-2.107**	0.046
Slurry import not permitted	-1.034***	0.000	-1.973**	0.044	-2.928***	0.005
One-off payment	-0.413	0.370	-19.204***	0.000	1.770	0.510
Annual payment	-0.514	0.230	-18.815***	0.000	1.446	0.530
Latent Class Membership						
Farmer is older than 50	0.000	0.000	0.103	0.770	0.842*	0.078
Farming training	0.000	0.000	-0.254	0.440	-0.384	0.430
Farm succession	0.000	0.000	0.410	0.170	-0.517	0.330
Full-time	0.000	0.000	-0.222	0.660	-0.996*	0.071
Commercial	0.000	0.000	-0.150	0.650	-3.626	0.280
Photovoltaics	0.000	0.000	0.852**	0.012	0.085	0.850
Utilised agricultural area	0.000	0.000	-0.035	0.600	-0.230	0.838
Closed system	0.000	0.000	1.812***	0.000	0.691	0.200
Top 25 farm	0.000	0.000	0.456	0.110	-0.341	0.520
North-West	0.000	0.000	-0.166	0.580	-0.113	0.800
Constant	0.000	0.000	-1.789***	0.003	-0.247	0.700
Log Likelihood	-2621,9222					
Pseudo-R²	0.403					
	Scale class 1		**Scale class 2**			
	Coef.	p-value	Coef.	p-value		
Scale factor (λ)	0.000	0.000	0.271***	0.000		
Scale class Membership model[b]						
Leased	0.000	0.000	2.000*	0.0531		
Barn older than 30 years	0.000	0.000	0.505*	0.0996		
Constant	0.000	0.000	-0.887***	0.00		
Probabilities of class membership						
	Class 1	**Class 2**	**Class 3**			
Scale Class 1	0.348	0.225	0.061	0.634		
Scale Class 2	0.208	0.119	0.038	0.365		
Total	0.556	0.344	0.09			

(Level of significance: *p<0.1;**p<0.05;***p<0.01)

[a] In total, 346 farmers were surveyed, every participant answered eight choice sets with four alternatives, yielding 11,072 choice observations (Source: own calculation with Latent Gold 6.0), [b] variables assumed to be influential for scale class membership were added to the model, the chosen variables improved model fit.

The variables 'Nitrogen balance', 'North-West' and 'Commercial' were included in the model to ascertain whether farms with a poor environmental balance face particularly great challenges and are more likely to participate in the programmes. However, the variables had no influence. This, and the high share of farmers considering support schemes in general, suggest that all farms face major challenges regardless of their current environmental impact.

Across all preference classes, respondents belonging to the second scale class were less confident in making their choices. This higher uncertainty is reflected in a smaller scale factor (λ=0.276) for the second scale class. The predicted probabilities of class membership in Table 4 show that 37 % of the respondents belonged to the second scale class. To reveal possible sources of uncertainty, characteristics of the farmer and their farms were added to the model that explains scale class membership. It was revealed that farmers who own barns that are older than 30 years and those who have already leased their barns to other farmers were more likely to show uncertainty. On the one hand, older barns could pose difficulties in meeting process quality standards and might be harder to amend to fulfil higher animal welfare standards. On the other hand, they could be cheaper to operate, for example because they are exempt from the requirement to use air filters. Leasing barns to other farmers is an alternative option.

Willingness-to-accept (WTA) compensation (Table 5) was calculated as the coefficients of the model do not provide information about the strength of the effects (Hensher *et al.* 2018). The WTA estimates are the marginal rate of substitution between an attribute and the monetary variable. They thus indicate how much compensation a respondent expects to receive for a one-unit increase in a negatively valued attribute, or how much compensation he or she is willing to give up for a one-unit increase in an attribute that is valued positively.

The respondents in the first preference class were expecting an extra annual payment of €5.53 per pig fattening place when they were banned from importing slurry from other farms. The corresponding figure for restricting slurry intake to the current level was €1.19. Furthermore, they would ask for an extra €2.94 per place and year when they were required to demolish their barn at their own cost. By contrast, they were willing to give up €1.68 per place and year if the costs of demolition were reimbursed. When re-investment is either prohibited or restricted to housing facilities with enhanced animal welfare standards, the respondents in the first preference class would request extra annual compensation of approximately €1.00 per pig fattening place.

The respondents belonging to the second preference class were not in favour of the exit scheme. This can be seen from the very high WTA estimates for the payment mode (around €23 per place), which lie outside the range of compensation payments offered in the choice sets (€12.50 to €20.00, see Table 1). Compared to respondents in the first preference class, they would expect higher compensation for demolition without cost reimbursement (€3.12 per place and year in addition) and for bans on barn construction (€2.15 per place in addition). However, restrictions on slurry imports were of less importance. They would ask for only half the amount if they were not allowed to import slurry (€2.45 per place in addition).

Table 5. Willingness-to-accept compensation (WTA) for the attributes of the support scheme calculated for the first scale class. Values for non-significant attributes were set to zero.

Preference class	**Class 1**		**Class 2**		**Class 3**[c]	
	Coef.	s.e	Coef.	s.e	Coef.	s.e
Demolition required	2.941	0.776	3.120	1.439	0.000	0.000
Demolition required with costs reimbursed	-1.683	0.544	0.000	0.000	0.000.	0.000
Barn construction (improved animal welfare)	1.053	0.610	0.000	0.000	0.000	0.000
Ban on barn construction	0.990	0.625	2.148	1.259	0.000	0.000
Slurry import at existing level	1.185	0.585	0.000	0.0004	0.000	0.000
Slurry import not permitted	5.532	0.875	2.450	1.207	0.000	0.000
One-off payment	0.000	0.000	23.851	1.798	-0.000	0.000
Annual payment	0.000	0.000	23.368	1.356	0.000	0.000

[c] WTA values were not calculated for the third preference class as the price coefficent was insignificant (Source: own calculation).

5 Discussion & Conclusion

The objective of this paper was to determine the acceptability of a hypothetical scheme for a state-subsidised exit from pig fattening in Germany. Around 65 % of the respondents opted for an exit scheme. The high acceptance rate may be explained by a changing legal framework, fluctuating market revenues and uncertainty about future political framework conditions for the sector. This has been underlined by the numerous demonstrations against the German government’s legislative packages organised by the new farmers' movement ‘Land Creates Connections’ and could explain why only few farmer and farm characteristics showed a significant influence.

The coefficients of the scheme’s attributes provide valuable information as to the issues that need to be considered prior to the launch of an exit scheme. The coefficient of the price attribute had the expected sign: higher compensation increased the probability of participation. Auctions could potentially significantly reduce the economic costs of implementing the exit scheme in reality (Schilizzi and Latacz-Lohmann, 2007). In the Netherlands enterprises received farm-specific offers to keep costs as low as possible (Wissenschaftliche Dienste des Deutschen Bundestages, 2019). The estimations further revealed a negative attitude towards very tight restrictions on the import of livestock manure and the ban on building barns. Softer restrictions were accepted by a smaller share of farmers.

A full ban on importing slurry was significantly negative, while limiting it to the current level was evaluated less negatively. Financially this can be explained by the ensuing need to purchase mineral fertilisers, but also by the income forgone from importing livestock manure from other farms. A full ban thus needs to be critically debated and balanced against the key objective of 'warm restructuring' to reduce damage to the environment caused by nitrogen surpluses. A second important scheme attribute is a potential ban on new barn buildings. In order to achieve the objectives of protecting animals and the environment, it might be politically desirable to reduce animal populations, especially in the strongholds of livestock production. Implementation of an exit scheme can therefore only be recommended if it contains restrictions on permissions for new barn buildings. In this respect, limiting re-investments to barns with enhanced animal welfare standards might be a good compromise. The exit scheme could therefore also help bring about changes in livestock farming in Germany.

The farm and personal characteristics considered in the regressions potentially shed light on suitable target groups, and show that the objectives of the scheme need to be precisely specified. Should it support a switch to more sustainable, animal welfare-oriented livestock farming with old barns being decommissioned? If so, a suitable target group would be farmers who display the characteristics of the first preference class, i.e. younger full-time farmer willing to grow the pig enterprise. If, however, the primary objective is to reduce animal numbers in a region, then the third preference class would be the suitable target group, i.e. older and part-time farmers and those who have leased their barns to other farmers. These farmers would consider the exit scheme as a kind of pension scheme. However, this is a very small group.

In principle any state intervention is bound to be a subject of debate. It is inevitable that farmers who are unable to produce cost-effectively under current conditions will eventually have to leave the industry. The slow process of adjustment is demonstrated in the articles of Balmann *et al.* (1996); Gardebroek and Oude Lansink (2004) and Hinrichs *et al.* (2008). From their perspective, the scheme would merely anticipate structural change in agriculture. This argument is supported by the socioeconomic and farm attributes of the third preference class. However, it has ultimately been accepted in Finland (Pietola and Väre, 2003) and the Netherlands (Government of the Netherlands, 2020b).

One argument in favour of an exit scheme is that a key objective of the Common Agricultural Policy is to safeguard a reasonable living for the rural population. To achieve environmental objectives, 'warm restructuring' explicitly makes provision for a 'soft' landing – a socially acceptable exit from pig production through appropriate payments.

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Appendix

Appendix Table 1. Example of a choice card used in the questionnaire for farmers specialised in pig fattening[1)]

	Option 1	Option 2	Option 3	Option 4
Compensation payment in € per fattening pig place	17,50 € per fattening place and year	15 € per fattenting place and year	20 € per fattening place and year	No participation
Demolition of decommissioned barns	Not required	required (costs reimbursed)	required	
Barn construction	Animal welfare only	Allowed	Ban of Barn Construction	
Slurry import	Not allowed	Existing level	Allowed	
Mode of payment	Annual payment	One-off payment	One-off payment	
I choose:	☐	☐	☐	☐

[1)] Farmers operating a closed system were also shown the compensation payments for sow places (see Table 1)

(Source: own illustration)