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Use and non-use values to explain farmers' motivation for the provision of animal welfare

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Abstract

This paper examines how differences in motivation in terms of use and non-use values affect the choice of animal welfare improvement practices. The application is focused on Swedish dairy farmers' preferences for different flooring systems' attributes. Using multiple indicators and multiple causes and hybrid latent class models, the findings demonstrate that dairy farmers who favour flooring solutions that enhance farm animal welfare are motivated by a complex set of both use values relating to internal and external pressures and non-use values linked to animal freedom, ethical codes of farmers and building business-to-customer relationships. The findings imply that measures to stimulate more uptake of animal welfare improvement practices can be better targeted by using insights into motivational constructs of farmers and by adopting policy communication that captures the whole breadth of use and non-use motivational constructs held by farmers.

Keywords: animal welfare, choice experiment, latent variable, non-use values, use values

JEL classification: C49, Q12, Q18, Q19

1. Introduction

It is currently well-established that animals as sentient beings can suffer when they are used in production processes, and consequently farmers are progressively adopting management practices that enhance farm animal welfare (Kauppinen *et al.*, 2010; Norwood and Lusk, 2012). Along with the increased understanding of animal suffering *per se*, the drive to improve animal welfare

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is prompted by the socio-economic implications, increased societal and consumer cognisance of animal welfare and the economic impact of animal welfare on farm economic outcomes (Lagerkvist and Hess, 2011; Hansson, Lagerkvist and Azar, 2018a; Norwood and Lusk, 2012).

Following societal and consumer awareness and understanding of farm animal welfare, the way farm animals are managed has become an attribute of the final consumer products. As preferences change with increasing consumer understanding through education and awareness creation, preferences for farm animal welfare are expected to rise with a change in consumer attitude, income levels and information. Consumers' economic responses to farm animal welfare are shown in the demand for food and their willingness to pay for livestock products with improved animal welfare status (Lagerkvist *et al.*, 2011). From the production point of view, farm animal welfare standards can affect farm economic outcomes. Depending on the type of farm animal welfare measure considered, a producer may incur revenue losses and variable cost adjustments owing to decreases in production intensities, capital investments or disinvestments (McInerney, 2004). On the other hand, there may be complementarity in farm economic outcomes, with increases in production from better farm management practices (e.g. improved nutrition, improved housing and disease control) to enhance farm animal welfare.

There are several stakeholders and driving forces in the debate around farm animal welfare. Several actors, including veterinarians, consumers and various pressure groups, directly or indirectly affect how animals are treated in production (Uehleke and Hüttel, 2019). However, farmers are the ones who make the actual decisions about what welfare efforts to provide and thereby ultimately determine the living conditions of animals in agricultural production (Kauppinen *et al.*, 2010). Understanding which motivational factors drive farmers' choice in situations that affect animal welfare is thus a key aspect in understanding farmers' provision of animal welfare and how this can be supported by various public or private policy instruments.

Farmers as economic agents are assumed to maximise their utility. Farm income or profit is often used as a proxy for utility (Romer, 2006). Indeed, the general behavioural assumption underlying the decision-making of farmers in the economic literature has, for a long time, been that they are only driven by motives of profit maximisation (Edwards-Jones, 2006; Romer, 2006). However, in recent years, this idea has been found not always to concur with the actual observed decisions made by farmers (Musshoff *et al.*, 2013; Howley, 2015; O'Donoghue and Howley, 2012). Several studies support the notion that farmers value not only financial goals but also a wide range of non-financial goals (McInerney, 2004; Darnhofer, Schneeberger and Freyer, 2005; Howley, 2015). Insights from these studies suggest that assessing decisions made by farmers regarding the choice of animal welfare improvement practices in financial terms alone may not give the requisite amount of information to design relevant policies regarding farm animal welfare.

The concept of use and non-use values has been put forward in recent years to explain the motivation of farmers in the provision of animal welfare. Use values in farm animal welfare are defined as the economic values derived from the productivity and profitability consequences of implementing animal welfare (McInerney, 2004; Lagerkvist *et al.*, 2011; Hansson *et al.,* 2018a). The use values in animal welfare are associated with business goals, i.e. where animal welfare is not the end goal. Non-use values of farm animal welfare are defined as the economic values obtained from good animal welfare and, regardless of the present or future use of animals in the production process, can explain why farmers may implement animal welfare beyond what is required from the point of view of animal welfare legislation, productivity or profitability (McInerney, 2004; Lagerkvist *et al.*, 2011; Lusk and Norwood, 2012; Hansson, Lagerkvist and Azar, 2018a). The kind of animal welfare improvement practices adopted by farmers depends on how they perceive use and non-use values of farm animal welfare (Lagerkvist *et al.*, 2011).

Although important in explaining farmers' decisions concerning farm animal welfare, the ways in which use values and non-use values actually affect choices made by farmers regarding animal welfare improvement practices have never been studied. Such knowledge would improve our understanding of how improvements in farm animal welfare can be stimulated by means of various public and private policy measures that directly allude to the type of motivation that drive farmer decisions. Such knowledge would also add to our understanding about how economic decisions are driven by values of a more financial type as well as by values of a non-financial type and would advance our understanding of economic behaviours in farms.

Hence, in this paper, our aim is to examine how differences in motivation in terms of use and non-use values affect the choice of animal welfare improvement practices. In particular, this study is focused on farmers' preferences for different flooring systems' attributes in dairy production in Sweden. A latent variable framework is used which offers a theoretical and empirical advantage in terms of measurement and potential endogenous biases. In this framework, the use and non-use motivational constructs are not incorporated into the utility functions directly. Instead, we include constructs resulting from confirmatory factor analysis of the use and non-use values to avoid measurement and endogeneity biases (Daly *et al.*, 2012; Mariel, Meyerhoff and Hess, 2015).

The type of flooring system in alleys and waiting areas used in free-stall barns for dairy cattle is an interesting element in discussions about farm management practices that enhance farm animal welfare in dairy production, because exposure to inadequate flooring is repeatedly mentioned as a risk factor for claw disorders and lameness (Barker *et al.*, 2010). Claw and leg disorders associated with lameness are considered the most important animal welfare issue in dairy production and constitute the major reason for mortality due to euthanasia on dairy farms (Alvåsen *et al.*, 2014). Improvement of the alley floor has been shown to provide better comfort for the animals as well as better claw health (Bergsten, Telezhenko and Ventorp, 2015). Slippery floors impede the cows' movements and heat expression (Palmer *et al.*, 2012; Telezhenko, Magnusson and Bergsten, 2017).

Thus, inappropriate flooring system may cause both lameness and impaired reproduction, contributing to major economic losses in milk production (Hogeveen, Van Soest and Van Der Voort, 2017).

This study contributes to existing knowledge in the following ways. Overall, this study is the first to include information about farmer motivation as a latent variable in a choice experiment. In particular, this paper explicitly tests the impact of use and non-use values on farmers' preferences for attributes of flooring systems. This makes it possible to unravel the direct impact of use and non-use values rather than merely assuming that farmers are driven by a profit-maximisation behaviour in their animal welfare related choices. Such insights are essential in understanding how public and private policy aiming at improving animal welfare on dairy farms can be more efficiently designed. At a more general level, we also contribute insights about how farmers' choices can be driven by values of a more financial type and values of a non-financial type. As such, findings can be used to improve models of farmers' economic behaviour. With this case study, we contribute to the understanding of demand for housing and management systems that are more animal friendly.

2. Materials and methods

2.1. Conceptual framework

In this study, the choice of flooring solution made by farmers is formulated based on random utility theory. We presume that the decision of the dairy farmer related to flooring systems is based on the expected benefits associated with the system (e.g. Swedish government's investment support for reconstruction of animal houses in a way that improve animal welfare and support for extended hoof health care for dairy cows and the positive effects on production as highlighted in the introduction). If farmers obtain utility only from the profit they obtain from their farm operations, the random utility would postulate that farmers are profit maximisers, thus making choices in their farm operations so that profit is maximised (Edwards-Jones, 2006; Romer, 2006; Lancaster, 1966). However, recent literature suggests that maximising financial utilities (i.e. utilities obtained from profit) is not the single motivation in farmers' decision-making (Howley, 2015) and that the actual observed choices made by farmers reveal important non-financial utilities (Howley, 2015; Musshoff *et al.*, 2013; O'Donoghue and Howley, 2012). In this study, we build on these insights and formulate choices made by farmers considering flooring solutions as depending on both financial and non-financial utilities obtained from the choice.

Behaviours and decisions which give rise to choices are considered to be directed by goals (Atkinson and Birch, 1970; Gollwitzer and Bargh, 1996). This means that the degree of motivation to pursue a particular goal depends on the subjective utility that is associated with each of the goals (Kopetz *et al.*, 2012). We posit in line with Hansson, Lagerkvist and Vesala (2018b) that economic value in animal welfare can be considered a motivational construct and that the use and non-use values are its attributes. This is because choices made by farmers with respect to animal welfare are assumed to be driven by the use and non-use value the farmers perceive in animal welfare (McInerney, 2004; Lagerkvist *et al.*, 2011; Hansson and Lagerkvist, 2016). Furthermore, building on Hansson, Lagerkvist and Azar (2018a), we posit that the subjective utility associated with each use and non-use value determines the importance farmers attach to each value as motivational factors in their choice. For this study, this implies that preferences of farmers for the use and non-use values in animal welfare determine their preferences for flooring attributes.

We employ a latent variable approach which avoids inherent bias that can arise from direct inclusion of indicators of attitudes (in this study introduced in terms of use and non-use motivational constructs) into the utility function (Hess, 2012). Various authors have captured latent variables in choice models in recent years. For example, Mariel, Meyerhoff and Hess (2015) and Paulssen, Vij and Walker (2014) incorporate social and psychological constructs into choice models to explain the decision-making process and factors influencing the process to improve the behavioural content in choice models. Swait, Franceschinis and Thiene (2020) incorporate latent variables in hybrid choice model to explore the role of goals and distance on preferences for recreational site attributes in Italy, and Bello and Abdulai (2018) use the approach to account for heterogeneous and market potential for organic products in Nigeria.

The direct inclusion of the attitudinal indicators as proxies for the latent variable in the utility function causes measurement and endogeneity biases (Daly *et al.*, 2012; Mariel, Meyerhoff and Hess, 2015). Thus, the latent variable approach was used. A factor analysis of the indicators is first performed and then the resulting constructs are modelled with the choice process jointly or separately (Daly *et al.*, 2012; Hess, 2012). Figure 1 visualises the conceptual framework. The first part is the latent variable framework that captures how farm and farmer characteristics influence use-non-use motivational constructs through the scores on use and non-use values. The second component is the choice-modelling framework, which measures how the scores of use and non-use motivational constructs of animal welfare, attribute levels of the flooring solutions as well as farm and farmer characteristics influence the utilities farmers derive from their choice of flooring solutions.

Scores of use and non-use motivational constructs of animal welfare predicted by the latent variable framework are incorporated in the choice framework to explain the dairy farmers' choice. In addition, farm and farmer characteristics are included in the choice framework. Thus, the farm and farmer characteristics are specified to influence both the utility function and the latent variables. Hence, there is a need for empirical approaches that address endogeneity bias and measurement error to attain consistent estimates. Consistent estimates can be attained using the limited information criteria (two steps, sequentially) and the full information criteria (one step, simultaneously) (Daly *et al.*, 2012; Mariel, Meyerhoff and Hess, 2015). In the limited information criteria, a multiple indicators and multiple causes (MIMIC) model is usually used

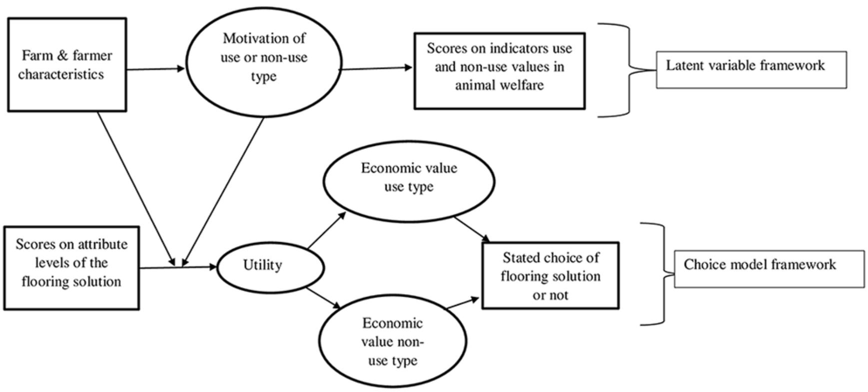

Fig. 1. Conceptual framework for the latent and choice variables.

to examine the relationship between socioeconomic variables and the attitudinal variables in the first stage using structural equations. The factor scores from the first stage are saved and included in the choice model (Diamantopoulos, 2006). The full information criteria estimate both the MIMIC and choice models concurrently (Ben-Akiva *et al.*, 1999; Daly *et al.*, 2012; Mariel, Meyerhoff and Hess, 2015). These criteria are more efficient but can suffer from convergence problems arising from multiple integrals (Bahamonde-Birke *et al.*, 2017). In this study, we use the hybrid latent class model which allows us to estimate the structural (*i.e.* farm and farmer characteristics) and measurement (use and non-use motivational constructs) components concurrently (Mariel, Meyerhoff and Hess, 2015).

2.2. Empirical model (hybrid latent class and MIMIC models)

2.2.1. Latent variable model (MIMIC)

The MIMIC model was used to capture the latent variable component of our conceptual framework (Anderson and Gerbing, 1988). The MIMIC model follows a two-step structural equation modelling process. In the first step, a confirmatory factor analysis is performed to test the relationship between the latent use and non-use motivational constructs and their observed indicators. Scores on use and non-use motivational constructs of animal welfare indicators (ϑ_{kln}) for latent variables l are specified to capture the effects of scores on their resultant latent variable Υ_{ln} and written as follows:

$$\vartheta_{kln} = k_{kl}.\Upsilon_{ln} + \mu_{kln} \tag{1}$$

where ϑ_{kln} is the score for dairy farmer n on the k^{th} indicator of latent variable Υ_l, μ_{kln} denotes the measurement error in a given score which is assumed to be uncorrelated across indicators with *i.i.d,* and k_{kl} denotes the factor loadings which capture the effects of Υ_l on k_{kl}. The fitness of equation (1) is tested using measures such as chi-square, root mean square error of approximation

(RMSEA), comparative fit index (CFI) and standardised root mean square residual (SRMR) (Bagozzi and Yi, 2012).

After testing for model fitness and validity of equation (1), the structural model is estimated in the second stage. In this stage, use-non-use motivational factors were specified to be partly explained by the farm and farmer characteristics measured as indicated in Figure 1:

$$\Upsilon_{ln} = \sum_{p} \gamma_{lp} x_{pn} + \varsigma_{ln} \tag{2}$$

where γ_{lp} are estimated coefficients that capture effects of the p^{th} dairy farmer or farm characteristics denoted by x_p and ς_{ln} denotes the error term with normally *i.i.d* assumption and permitted to correlate across latent variables. Equations (1) and (2) are estimated jointly as an MIMIC model.

2.2.2. Choice model (hybrid latent class)

We assume that farmers' utility from floor choice consists of utilities of use-value type and non-use value type. The overall utility U_{ins} of alternative i for dairy farmer n in choice scenario s is the sum of use-value type and of non-use value type. Thus, we define U_{ins} to consist of use-value type and non-use value type utilities of option i for dairy farmer n in choice scenario s. Supposing that a rational dairy farmer n chooses flooring alternative i in choice scenario s when faced with available options Q_{ns}, $U_{ins} > U_{jns}; \forall_k \neq i, j \in Q_{ns}$. Here U_{jns} denotes utility for alternative j. The utility U_{ins} of option i for dairy farmer n in choice scenario s is specified as follows:

$$U_{ins} = V(z_{ins}, x_n, \vartheta_n, \alpha) + \ell_{ins} \tag{3}$$

where U_{ins} is the latent unobservable utility for the i^{th} alternative in the choice scenario s for dairy farmer n; $V(z_{ins}, x_n, \vartheta_n, \alpha)$ represents the observable systematic portion of the utility function, z_{ins} is a vector of floor attributes of alternative *i*, x_n denotes farmer and farm characteristics, ϑ_n denotes latent variables of use and non-use values of animal welfare, α is a vector of parameters to be estimated for the farmer and farm characteristics, use and non-use motivational factors and flooring attributes. Finally, ℓ_{ins} is the random element of the utility which is independent and identically distributed (*i.i.d*).

The prime assumption of the latent class model is that the sampled dairy farmers consist of discrete classes C. Each identified class has unique utilities φ_C. Considering that dairy farmer n belongs to class c, the conditional probability (P_n) of the farmer choosing alternative i in choice condition s is stated as follows:

$$P_n = \Pr\left({}^{q_{ns}}/_{C}, z_{ins}\right) = \prod_{S=1}^{S_n} \frac{exp^{(\varphi_C Z_{ins})}}{\sum_{l=1}^{L} exp^{(\varphi_C Z_{ins})}} \tag{4}$$

where q_{ns} denotes the order of choices made by dairy farmer n across S_i and z_{ins} is the vector of floor attributes of farmer *n's* choice alternative *i*.

Equation (4) follows the multinomial logit probability outcome with one of the scale parameters fixed to allow for identification. Dairy farmer's allocation to a given class is probabilistic, and we define the class allocation probability (Ω_n) for farmer n logistically as follows:

$$\Omega_{n,c} = \frac{exp^{\left(\theta_{o,C}+\gamma_C x_n\right)}}{\sum_{C=1}^{C} exp^{\left(\theta_{o,C}+\gamma_C x_n\right)}} \tag{5}$$

For a given identified class, its utility is a function of the farmer and farm characteristics (x_n), while γ_C and θ_o denote vectors of parameters and a constant for class c, respectively. The unrestricted likelihood over the order of realistic choices made by the dairy farmers is calculated by finding the expectation over all classes, C and written as follows:

$$P_i = \Pr\left(q_{ns}/_{Z_{ins}}\right) = \sum_{c=1}^{C} \Omega_{n,c} \prod_{S=1}^{S_n} \frac{exp^{\left(\varphi_C Z_{ins}\right)}}{\sum_{l=1}^{L} exp^{\left(\varphi_C Z_{ins}\right)}} \tag{6}$$

It is important to note that the utility of the classes as specified in equation (5) is a function of only farmer and farm characteristics. We did not include the latent variables (ϑ_n) which consist of farmers' use and non-use values motivational constructs directly due to potential endogeneity and measurement problems discussed above (Ben-Akiva *et al.*, 1999; Daly *et al.*, 2012). Rather, we incorporate the scores on use and non-use motivational constructs generated from the MIMIC model into the choice model. Thus, we specify that for a given use-non-use motivational factor k generated for dairy farmer n, the estimate of the k^{th} factor score is rewritten in the choice framework as follows:

$$t_{kn} = \lambda\left(\vartheta_{kln}, \xi\right) + \varepsilon_{kln} \tag{7}$$

where t_{kn} is a function of ϑ_{kln} and a vector of parameters (ξ); ε_{kln} is a random term with logistic distribution, l_n. We used the ordered logit framework for the motivational factors, which consist of use and non-use values $t_1 - t_r$. The probability of a given observed use and non-use motivational factor t_{kn} $(k = 1 \ldots .y)$ is specified as follows:

$$\begin{aligned} T_{t_{kn}} \quad = \quad & t_{(t_{kn}=i_1)}\left[\frac{exp^{(\tau_{k_{i_1}}-\xi_k\vartheta_n)}}{1+exp^{(\tau_{k_{j_1}}-\xi_k\vartheta_n)}}\right] \\ & + \sum_{y=1}^{Y-1} t_{(t_{kn}=i_1)}\left[\frac{exp^{\left(\tau_{k,y}-\xi_k\vartheta_n\right)}}{1+exp^{\left(\tau_{k,y}-\xi_k\vartheta_n\right)}} - \frac{exp^{\left(\tau_{k,(y-1)}-\xi_k\vartheta_n\right)}}{1+exp^{\left(\tau_{k,(y-1)}-\xi_k\vartheta_n\right)}}\right] \\ & + t_{(t_{kn}=i_Y)}\left[1 - \frac{exp^{\left(\tau_{k,(Y-1)}-\xi_k\vartheta_n\right)}}{1+exp^{\left(\tau_{k,(Y-1)}-\xi_k\vartheta_n\right)}}\right] \end{aligned} \tag{8}$$

where

ξ_k captures the influence of the unobserved variable (ϑ_n) on the motivational indicator t_{kn}. Equation (8) measures the likelihood of each observed value of the use and non-use motivational indicators (t_{kn}) which consist of the constructs of use and non-use values. The set of calculated threshold parameters from equation (8) is denoted by $\tau_{k,1}, \tau_{k,2} \ldots \tau_{k,Y-1}$. Empirically, each $\tau_{k,1}, \tau_{k,2} \ldots \tau_{k,Y-1}$ is calculated using a set of ancillary parameters $\delta_{k,1}, \delta_{k,2} \ldots \delta_{k,(Y-1)}$ such that

$$\tau_{k,2} = \tau_{k,1} + \delta_{k,1}, \tau_{k,3} = \tau_{k,2} + \delta_{k,2}, \ldots, \tau_{k,Y} = \tau_{k,Y-1} + \delta_{k,Y-1} \qquad (9)$$

where $\delta_{k,Y} \geq 0 \forall Y$. The definition of the ancillary parameters ensures that $\tau_{k,1} < \tau_{k,2} < \ldots \tau_{k,(Y-1)}$. ϑ_n is included in the model through the class allocation probabilities in equation (5) and re-written as follows:

$$\Omega_{n,c} = \frac{exp^{(\theta_{o,c} + \gamma_c x_{ml} + \lambda_c \vartheta_{kln})}}{\sum_{C=1}^{C} exp^{(\theta_{o,c} + \gamma_c x_{ml} + \lambda_c \vartheta_{kln})}} \qquad (10)$$

where θ_o, γ_c and λ_c denote parameters to be estimated. The impact of the use and non-use motivational constructs of animal welfare (ϑ_{ln}) in explaining the likelihood of dairy farmer *n* belonging to a given class is indicated by the sign of λ_c. Also, the impact of the farmer and farm characteristics on class assignment is indicated by the sign of γ_c. The model integrates the choice equations with the measurement component capturing the use and non-use motivational constructs over μ_{ln}, reliant on the underlying variable (ϑ_{ln}). The joint log-likelihood equation of the integrated or hybrid latent class model is specified as follows:

$$LL(\varphi, \theta, \Upsilon, \xi, \tau) = \sum_{n=1}^{N} ln \int_{\psi} \left[P_i \prod_{k=1}^{5} T_{t_{kn}} \right] g(\psi)\, d\psi \qquad (11)$$

P_i is defined in equation (6), with class allocation probabilities specified in equation (10) as $\Omega_{n,c}$; $T_{t_{kn}}$ is defined in equation (8) for $k = 1 \ldots 5$. We used the Krinsky and Robb approach to compute class-specific monetary values attached to the floor attributes.

2.3. Sampling and data description

Data used in this study were obtained from a sample of Swedish specialist dairy farms through an online survey. A random sample of 700 individual farms was drawn from the official register, operated by Statistics Sweden. Inclusion criteria were that (i) the farm should be specialised in dairy production (according to Swedish agricultural statistics typology) (Statistics Sweden, 2016) and (ii) it should be large enough to provide full-time work to at least the farmer him/herself. The latter criteria ensured that very small farms, which are kept mostly for lifestyle and hobby reasons were excluded. The online survey mode, compared to individual interviews and paper-and-pen surveys, was considered appealing and efficient in Sweden, where as much as 98 per cent of the population has access to internet in the household (Internetstiftelsen, 2019). To ensure confidentiality and respondent anonymity to the researchers, a marketing research company, without any self-interest in the study, collected the data on behalf of the research group, which only received anonymous data. Data collection took place during late November and the first half of December, 2019.

From the initial sample of 700 dairy farms, three were excluded because they were of institutional type (high schools and university farms). A total of 697 dairy farmers were thus invited to participate in the survey through a postal letter and electronic message by text and e-mail. After two additional reminders, a total of 246 responses were obtained (response rate ~35 per cent). After removing incomplete responses from the total responses, 142 responses were usable; the effective response rate was thus ~20.37 per cent (*i.e.* 142/697).

The first part of the survey data consisted of information on the dairy farmers and on production characteristics such as years in dairy farming, herd size, the type of production system operated by the farmer, the housing system and milk output. The second part contained information on the farmers' use and non-values perceived in animal welfare (Refer to Appendices A1 and A2 (Appendix in supplementary data at ERAE online) for the set of affirmations). The last part of the survey focused on farmers' preferences for and choice of flooring attributes in choice experimental setting. Descriptive statistics of farm and farmer characteristics are presented in Table 1. Compared to the Swedish Board of Agriculture's 2018 mid-year statistics, the average number of dairy cows per herd of 101 cows in this study is higher than the 92 dairy cows per herd observed in June 2018 (Swedish Board of Agriculture, 2019).

The 26 per cent share of organic farms does not differ significantly from the 22 per cent reported in June 2018 (Swedish Board of Agriculture, 2020). It is important to mention that this study focused on larger dairy farms that are big enough to provide full time job opportunities for at least one person including the farmer, and this might be the reason for the deviation from the official statistics of the Swedish Board of Agriculture, which consists of different categories of dairy farmers. Most of the respondents have recorded floor related diseases or injuries (e.g. claw lesions, lameness and sole ulcer) on their dairy farm.

2.4. Experimental design

Attribute-based choice experiment was used in the survey because at the time of the survey not all the dairy farmers had invested in new floors, so in order to create a comparative situation, all the farmers were exposed to a hypothetical scenario in a choice experiment as they would in a real situation. The discrete choice experiment employed allows the dairy farmers to choose from different flooring solutions with different combinations of flooring attributes. The choices made by the dairy farmers reveal their preferences for different floor solutions (Norwood and Lusk, 2011). The attributes considered in the choice

Table 1. Descriptive statistics of the farmer and farm characteristics

Variables	Description	Min.	Max.	Mean	Std. dev.
Age	Age of farmer in years	25	76	51	12
Years_dairy	Years in dairy farming	1	52	24	13
Dairy_income	Proportion of farm total revenue from dairy production (%)	10	100	76	17
Dairy_disp_income	Proportion of household total disposable income (after tax) from dairy production (%)	0	100	65	32
Milk_yield	Average milk yield per cow (energy-corrected milk ECM/year) in kg	6,500	13,790	10,315	1,360
Dairy cows	Number of dairy cows	12	450	101	81
Heifers	Number of heifers aged 1–2 years	6	157	46	37
Calves	Number of calves aged below 12 months	7	702	55	66
		Categories			%
Gender	Gender of respondent	Male (1)			78
		Female (0)			22
A_education	Whether the dairy farmer has agricultural education	Yes (1)			53
		No (0)			47
Production_sys	System of dairy production	Conventional (1)			74
		Organic (0)			26
Swedish_FAW_EM	Whether dairy farmer agrees or disagrees that Swedish animal welfare is overemphasised	Agree (1)			25
		Disagree (0)			75
Housing_sys	Current dairy housing system used by the farmer	Tie stalls only			22
		Loose housing only			59
		Loose housing and tie stalls			19
Off_farm	Whether the dairy farmer has any off-farm employment	Yes (1)			13
		No (0)			87
Floor_problems	Whether the farmer has recorded any floor-related diseases or injuries on the dairy farm	Yes (1)			68
		No (0)			32
Barn_reconstruction	Whether the farmer has reconstructed his or her barn before	Yes (1)			68
		No (0)			32

Table 2. Flooring attributes and levels in choice experiment

Attributes	Levels	Coding structure
Slippery risk	Low	1 = Low, 0 = Average, −1 = High
	Average	0 = Low, 1 = Average, −1 = High
	High	0 = Low, −1 = Average, 1 = High
Abrasion	Low	1 = Low, 0 = Average, −1 = High
	Average	0 = Low, 1 = Average, −1 = High
	High	0 = Low, −1 = Average, 1 = High
Softness	Soft, Hard	1 = Soft, −1 = Hard
Manure removal	Robotic scrapper Mechanic scraper	1= Robotic scrapper, −1= Mechanic scraper
Quality maintenance	Every 10th year (130 SEK per m²)	1= Every 10th year (130 SEK per m²)
	Every 5th year (70 SEK per m²)	−1= Every 5th year (70 SEK per m²)
Installation cost (m²)	400 SEK per m² 750 SEK per m² 1,300 SEK per m²	Continuous

SEK, Swedish Krona.

experiment include risk of slipping, abrasiveness, softness, manure removal method, quality maintenance, cost and source of information on floor, claw and leg health (not included in the present analysis). These attributes and their levels presented in Table 2 were obtained from previous experimental studies on the impact of different flooring systems on animal health and welfare (Telezhenko *et al.*, 2009; Bergsten, Telezhenko and Ventorp, 2015)

The selected attributes were further discussed with Swedish dairy farming, animal health and welfare experts. These selected attributes are very relevant to dairy production output, animal health and welfare status (Telezhenko *et al.*, 2009). Slipperiness is regarded as one of the most undesirable characteristics of alley floors causing lameness (Bran *et al.*, 2019) and impairing natural locomotion behaviour (Telezhenko, Magnusson and Bergsten, 2017). Moderate roughness is usually desirable for the hard floors, as it increases floor friction, claw grip and prevents claw overgrowth by wearing of claw horn (Franck *et al.*, 2007). Too much abrasion due to excessive roughness results in excessive wear of claw horn which also leads to improper force distribution, and thin soles causing claw lesions and lameness (Telezhenko, Lidfors and Bergsten, 2007). Softness of the floors is a characteristic which positively affects comfort and activity of dairy cows. Cows prefer to stand and walk on a softer surface (Telezhenko, Lidfors and Bergsten, 2007) as well as showing higher activity on the softer floors (Platz *et al.*, 2008). The hygiene of the floor is another important aspect of the floor quality as better hygiene provides not only better claw health (Barker *et al.*, 2010) with respect to infectious and hygiene-related lesions but also udder cleanliness which is important for mastitis prevention (Magnusson, Herlin and Ventorp, 2008). Floor hygiene is dependent on both floor design and on efficiency of the manure cleaning technique (Magnusson, Herlin and Ventorp, 2008).

All the variables, apart from installation cost, were effect-coded in order not to confound the utility function's grand mean and to account for non-linear effects in the attribute levels (Hensher, Rose and Greene, 2005). A full factorial design for three attributes with three levels (i.e. slippery risk, abrasion and installation cost) and three attributes with two levels (i.e. softness, manure removal and quality maintenance) would have resulted in $3^3 \times 2^3$ profiles, which was not considered feasible to work with. Therefore, the fractional factorial design was used to minimise the number of choice profiles. The fractional factorial design generated 32 choice profiles. From these choice profiles, 16 choice sets were generated using cyclic design. The 16 choice sets were blocked into four, with each block containing four choice sets. Each choice set had two options A, B and a 'none option'. Each respondent was randomly allocated to a block consisting of four choice sets. The choice sets were presented in Swedish (see sample in Appendix B (Appendix in supplementary data at ERAE online)).

3. Results

3.1. Latent variable (MIMIC) results

Table 3 presents results of the latent variable model, which tests how the latent use and non-use motivational constructs relate to their observed indicators and to farm and farmer characteristics. The table also presents details about which indicators each latent construct consists of. The latent constructs consist of (i) two constructs of use value type, here labelled as internal and external pressures, and of (ii) three constructs of non-use value type, here labelled as animal freedom, ethical codes of farmers and building business-to-customer relationships. Refer to Table 3 for details about which indicators each latent construct consists of. The descriptive statistics of indicators of use and non-use values are presented in Appendices A1 and A2 (Appendix in supplementary data at ERAE online). In the interest of brevity, these are not discussed in this paper. Detailed empirical content and structure of these constructs and indicators used are reported in previous studies by Hansson and Lagerkvist (2016) and Hansson, Lagerkvist and Azar (2018a).

The hypothesised latent constructs were validated using composite reliability and average variance extracted (AVE). The CR figures for the two use-values relating to internal and external pressures were 0.75 and 0.71, while for the three non-use values namely animal freedom, ethical codes of farmers and building business-to-customer relationships the figures were 0.84, 0.81 and 0.79, respectively. The AVE values for use values relating to internal and

Table 3. Latent use and non-use motivational constructs of farm animal welfare

Variables	Use values		Non-use values		
	Internal pressure	External pressure	Animal freedom (existence values)	Ethical codes of farmers (existence values)	Business-customer relations (paternalistic altruism)
Structural model	Coef. (R. Std. Err.)	Coef. (R. Std. Err.)	Coef. (R. Std. Err.)	Coef. (R. Std. Err.)	Coef. (R. Std. Err.)
Age	−0.09***(0.01)	−0.26**(0.11)	−0.32***(0.09)	−0.17(0.14)	−0.02 (0.02)
Male	−0.07*(0.04)	−0.03(0.026)	−0.10***(0.01)	−0.18***(0.02)	−0.14***(0.03)
A_education	−0.04(0.03)	0.37**(0.11)	−0.10***(0.01)	−0.18***(0.02)	−0.09***(0.02)
Years_dairy	0.04**(0.02)	0.25*(0.13)	0.22**(0.10)	0.04***(0.01)	0.33**(0.14)
Dairy_income	0.02***(0.00)	−0.04 (0.03)	0.17***(0.04)	0.10**(0.05)	−0.03(0.04)
Dairy_disp_income	0.02***(0.00)	0.03(0.02)	0.03(0.03)	0.07*(0.04)	0.07*(0.04)
Off_farm	−0.12***(0.04)	0.01(0.02)	−0.04*(0.02)	0.03(0.03)	−0.08*(0.04)
Milk_yield	−0.04 (0.20)	−0.35***(0.10)	−0.16(0.12)	−0.28**(0.12)	−0.39***(0.12)
Floor_problems	−0.01 (0.04)	−0.04**(0.02)	0.024(0.02)	0.01(0.03)	−0.04 (0.02)
Conventional_sys	0.27***(0.05)	0.07***(0.03)	0.11***(0.02)	0.14***(0.03)	0.16***(0.03)
Explained variance (R^2)	0.18	0.17	0.19	0.16	0.15
Measurement model					
UVI-1	0.20*** (0.02)				
UVI-2	1.00***(0.04)				
UVI-3	0.63***(0.04)				

(continued)

Table 3. (Continued)

Variables	Use values		Non-use values		
	Internal pressure	External pressure	Animal freedom (existence values)	Ethical codes of farmers (existence values)	Business-customer relations (paternalistic altruism)
UVI-4	0.64***(0.04)				
UVI-5	0.55***(0.04)				
UVI-6		5.46***(1.79)			
UVI-7		3.98***(1.25)			
NUVI-1			0.18***(0.01)		
NUVI-4			1.57***(0.07)		
NUVI-7			1.11***(0.05)		
NUVI-8			1.51***(0.09)		
NUVI-9			1.49***(0.07)		
NUVI-10			1.41***(0.05)		
NUVI-11			1.66***(0.09)		
NUVI-2				0.11***(0.01)	
NUVI-3				0.79***(0.09)	
NUVI-5				1.13***(0.05)	
NUVI-6				1.19***(0.04)	
NUVI-12					0.76***(0.03)
NUVI-13					1.32***(0.13)
NUVI-14					1.11***(0.10)
NUVI-15					1.36***(0.14)
NUVI-16					1.48***(0.13)
NUVI-17					1.21***(0.11)

(continued)

Table 3. (Continued)

	Use values		Non-use values		
Variables	Internal pressure	External pressure	Animal freedom (existence values)	Ethical codes of farmers (existence values)	Business-customer relations (paternalistic altruism)
NUVI-18					1.26***(0.12)
Disturbance term intercorrelations					
Internal pressure	1				
External pressure	0.52***	1			
Animal freedom	0.59***	0.87***	1		
Ethical codes of farmers	0.54***	0.91***	0.74***	1	
Business-customer relations	0.51***	0.68***	0.70***	0.70***	1

Notes: Goodness of fit indicators: RMSEA = 0.05, CFI = 0.98, TLI = SRMR= 0.03; Chi-square = 1.40; UVI = Use Value Indicator: NUVI = Non-Use Value Indicator; ***, **, * show significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

external pressures were 0.65 and 0.74, respectively. AVE values of animal freedom, ethical codes of farmers and building business-to-customer relationship were 0.75, 0.72 and 0.71, respectively. The CR and AVE statistics validate the hypothesised latent constructs in this study. The validity of the latent constructs and the fitness of the final MIMIC model were tested using indicators such as Chi-square, RMSEA, CFI and SRMR. The model exhibited good fitness with Chi-square value of 1.40 significant at 5 per cent level, RMSEA was 0.05, CFI was 0.98 and SRMR was 0.03.

The results presented in Table 3 show that farmer age is negatively associated with use values relating to internal and external pressures and non-use value relating to animal freedom. This implies that older farmers are less likely to have high use value motivational factors relating to internal and external pressures and non-use value motivational factors relating to animal freedom. Being a male dairy farmer is negatively related to the three non-use values and use value relating to internal pressure.

Agricultural education is positively associated with use-values of the type external pressures and negatively related to all the non-use values. Farmer experience is positively associated with all the use and non-use values. A higher proportion of farm income from dairy production is positively related to use value relating to internal pressure and non-use values relating to animal freedom and ethical codes of farmers. A high proportion of disposable income from dairy production is positively related to internal pressure, ethical codes of farmers and building business-to-customer relationship. It is worth mentioning that farm income and proportion of disposable income from dairy production are positively correlated but not significant. High milk yield per dairy cow is negatively associated with external pressures, ethical codes of farmers and building business-to-customer relationship. Conventional production system is positively associated with all the use and non-use values. This is interesting and signals the focus on ensuring good animal health as well as maintaining good business-customer relationship in Sweden. The farm and farm characteristics explained only 18 and 17 per cent of the variations in internal and external pressures of use values, respectively. Similarly, 19, 16 and 15 per cent of the variations in animal freedom, ethical codes of farmers and building business-to-customer relationship were explained by the observed farm and farmer characteristics, respectively. The remaining unexplained variance captured by the error terms is distributed between the latent variables as indicated by the significant error term inter-correlations. This implies that inter-correlation between the latent variables of use and non-use constructs plays a role in explaining farmers' motivation regarding farm animal welfare and hence supports the inclusion of the latent variables and their interactions in the measurement component of the choice model.

3.2. Utility estimates from the hybrid latent class model

We first tested the appropriateness of conditional, mixed logit, and latent class and found that the latent class model fits our data better. Two optimal latent classes were identified using Akaike information criteria (AIC) and Bayesian information criteria (BIC). Likelihood ratio test further showed that the hybrid latent class model performed better than the standard latent class model (See Appendix C (Appendix in supplementary data at ERAE online)) and hence we present the results of the hybrid model in Table 4. The results indicate that 46 per cent of the respondents fit into class one and the remaining 54 per cent belong to class two. The cost variable is significantly negative in both classes, as anticipated and in line with economic theory (McFadden, 1974).

Highly slippery and too abrasive floors are considered undesirable characteristics of alley floors, causing lameness and impairing natural locomotion behaviour cows and as such high levels of slippery risk and high abrasion level were used as base levels for slip risk and abrasion.

In class one, members attain significant and positive utility from a long quality maintenance period of 10 years, relative to 5 years maintenance period. The same class one members have significant and negative utilities from average slip risk and abrasion and use of robotic scrapers. Robotic scrapers are not preferred to mechanic scrapers. Members of this class also attain positive utility estimates from low slip risk, low abrasion and softness of the floor. Albeit that these utilities are not significantly different from zero at any of the conventional levels of significance, suggesting that this class is indifferent to low slip

Table 4. Dairy farmers' utility estimates and preferences for different flooring attributes[a]

Respondents	142			
Observation	1,704			
Log-likelihood	−424.14			
Parameters	13			
AIC	874.28			
BIC	866.30			
Classes	Class 1		Class 2	
Class probabilities	0.46		0.54	
Utility function	*Coefficient*	*Z*	*Coefficient*	*Z*
φLow slippery risk	0.09	0.25	1.46***	7.93
φAverage slippery risk	−0.98**	−2.44	0.86***	4.87
φLow abrasion	0.52	1.29	0.35**	2.26
φAverage abrasion	−0.95***	−3.75	−0.27*	−1.86
φSoftness	0.43	1.40	0.89***	4.26
φRobotic scraper	−0.63**	−1.97	−0.31*	−1.87
φEvery 10^{th} year	1.66***	4.57	−0.04	−0.25
φNone	−0.77	−1.56	−0.42**	−2.32
φCost	−0.00***	−4.13	−0.00**	−2.34
Class allocation function				
θ_2	0.83***	12.63		

***, **, * show significance at 1 per cent, 5 per cent & 10 per cent levels, respectively.
[a]Dependent variable: choice (1 if a dairy farmer chooses any of flooring options A or B and 0 if the 'none option' is chosen).

risk and abrasion, as well as softness of the floor. The 'none' alternative was negative but insignificant in this class. Members of this class can be said to be focusing more on longevity of floor as indicated by the only significant and positive estimate for 10 years maintenance. Dairy farmers in class one are considered as being *indifferent* towards alternative flooring solutions that improve animal welfare because their preference for low slip risk, low abrasion and softness attributes were insignificant. In addition, the status quo option was not significant which supports labelling class one as being indifferent towards animal welfare-enhancing flooring solutions. The highly significant and positive utility estimate for 10 years maintenance of floor suggests that, at present, the farmers in this segment are more concerned about the durability of floors.

Class two members obtain significant and positive utility from floor solutions with low and average slip risk compared with flooring alternatives with a high risk of slipperiness. In addition, members of this class have significantly positive utility estimates from low abrasive and soft floors. The results also show that class two members have significant and negative utilities from average level of abrasion relative to high abrasion. Robotic scrapers are negatively preferred in class two compared with mechanic scrapers. In terms of the status quo alternative, the results show a significantly negative estimate in class two. Dairy farmers in this segment are classified as proponents of alternative flooring solutions that enhance farm animal welfare since their utilities relating to low and average slip risk, low abrasion and soft flooring attributes were positive. Additionally, members of this segment have a negative preference for flooring alternatives with average levels of abrasion relative to high abrasion as well as the status quo alternative. Thus, dairy farmers in class two prefer soft floors with low to average slip risk and low abrasion and these attributes enhance the welfare of farm animals (Bergsten, Telezhenko and Ventorp, 2015; Platz *et al.*, 2008). This supports the labelling of class two members as proponents of farm animal welfare-enhancing flooring alternatives.

Generally, there are significant variations in the utility estimates in both classes in terms of magnitude and direction. The significant and positive allocation function estimate indicates that dairy farmers with higher latent constructs are more likely to fit into class two than class one.

3.3. Impact of use and non-use motivational constructs on flooring choice

Table 5 reports estimates of use and non-use motivational constructs in describing the segments of dairy farmers identified. It is important to mention that farmer and farm characteristics were included as structural components in the hybrid latent class model to provide detailed explanations for the sources of heterogeneity. Table 5 show that all the use and non-use motivational constructs ($\lambda_{t_1} - \lambda_{t_5}$) were significantly different from zero, suggesting that dairy farmers who prefer soft floors with low to average slip risks and low abrasion have a higher likelihood of being associated with higher values of all the five use and non-use values. The MIMIC model results that showed that all the indicators were significant and the significant inter-correlation terms support this finding. Specifically, the two use values relating to internal pressure ($\bar{\lambda}_{t_1}$) and external pressures ($\bar{\lambda}_{t_2}$) were positive and highly significant at the 1 per cent level. This finding implies that proponents of soft floors with low to average slip risk and low abrasion have a higher likelihood of being associated with higher use value types internal and external pressures.

Similarly, animal freedom ($\bar{\lambda}_{t_3}$), ethical codes of farmers ($\bar{\lambda}_{t_4}$) and building business-to-customer relationship ($\bar{\lambda}_{t_5}$) were highly significant and positive at

Table 5. Impact of farmer and farm characteristics, use and non-use motivational constructs on flooring choice

Variable	Coefficient	Z
Structural Equations (Effect of farmer & farm characteristics)		
γ_{Age}	0.04***	3.76
γ_{Male}	0.96***	15.37
$\gamma_{A\_education}$	0.71***	37.25
γ_{Years_dairy}	0.03	1.62
γ_{Dairy_income}	0.04**	2.64
$\gamma_{Dairy\_disp\_income}$	0.04***	2.51
γ_{Off_farm}	1.71***	90.27
$\gamma_{Swedish\_FAW\_EM}$	−0.01	−0.29
γ_{Milk_yield}	0.09***	14.41
$\gamma_{Floor\_problems}$	0.73***	39.46
$\gamma_{Conventional\_sys}$	0.25***	13.77
$\gamma_{Barn\ reconstruction}$	0.83***	53.74
Measurement Equation (Effects of use &non-use values)		
$\bar{\lambda}_{t_1}$	1.07***	24.03
$\bar{\lambda}_{t_2}$	0.81***	35.39
$\bar{\lambda}_{t_3}$	0.99***	18.59
$\bar{\lambda}_{t_4}$	1.09***	26.53
$\bar{\lambda}_{t_5}$	1.09***	27.22
Measurement Equation		
$\lambda_{t_1,1\&2}$	−0.07***	−2.80
$\lambda_{t_1,3,4\&5}$	0.97***	13.87
$\lambda_{t_2,1\&2}$	−0.14***	−3.07
$\lambda_{t_2,3,4\&5}$	0.49***	10.25
$\lambda_{t_3,1\&2}$	−0.52	−0.99
$\lambda_{t_3,3,4\&5}$	0.79***	12.88
$\lambda_{t_4,1\&2}$	0.17***	4.41
$\lambda_{t_4,3,4\&5}$	0.12***	6.14
$\lambda_{t_5,1\&2}$	−0.19**	−6.52
$\lambda_{t_5,3,4\&5}$	0.93***	13.89

***, **, * show significance at 1 per cent, 5 per cent and 10 per cent levels, respectively.

1 per cent level, suggesting that proponents of soft floors with low to average slip risk and low abrasion have higher likelihood of being associated with higher non-use values relating to animal freedom, ethical codes of farmers and building business-to-customer relationship. In addition, the proponents of alternative flooring solutions are less likely to be linked to higher threshold estimate combining internal and external pressures but positively associated with higher threshold estimates comprising of all the three non-use values.

Relative to the reference class (one), proponents of soft floors with low to average slippery risk and low abrasion are more likely to be male and older dairy farmers with agricultural education and off-farm employment. Agricultural education was significant and negatively related to the non-use motivational constructs in the MIMIC model. However, in the choice model, it has positive influence on farmers' choice of flooring solution. It is important to mention that the MIMIC model established relationship between the use and non-use motivational constructs and not the choice of flooring attributes and as such the positive sign of agricultural education in flooring choice is not surprising. In addition, we found that the farm and farmer characteristics including agricultural education explained little variations in the use and non-use motivational constructs. The proponents of soft floors with low to average slip risk and low abrasion are also more likely to be dairy farmers with higher milk yield and higher proportion of their farm and disposable incomes from dairy production.

In addition, this segment of farmers who prefer soft floors with low to average slip risk and low abrasion are more likely to be conventional dairy farmers who have experienced floor-related diseases and injuries on their farm before. The results further reveal that proponents of soft floors with low to average slip risk and low abrasion are more likely to be dairy farmers who have reconstructed their cattle barn before.

Table 6 reports dairy farmers' monetary valuation of the flooring attributes. A positive value indicates how much the dairy farmer would be ready to offer for a particular flooring attribute to be changed from its reference category, whereas a negative value represents the amount the dairy farmer is willing to offer to avert a change. The results show that the monetary values attached to the same flooring attributes differ between the two classes of dairy farmers. The estimates reveal that class two members are willing to offer SEK2432 (€233) for the risk associated with highly slippery floors to be reduced to low risk level, relative to class one.

In addition, members of class two are willing to offer SEK 1,478 (€142) for hard floors to be changed to soft floors. This is contrary to findings of Bruijnis *et al.* (2013) who found that Dutch farmers were not willing to pay for softer floor. Members of class one are willing to offer SEK 947 (€91) to prolong durability of floors from 5 years to 10 years. Members of class one are also willing to pay SEK 561 (€54) to prevent a change from high slip risk to average slippery level. They are also willing to pay SEK 542 (€52) to prevent a change from high abrasion to average level.

Table 6. Implicit trade-offs and monetary valuation of flooring attributes[a]

	Class 1 (SEK)	Class 2 (SEK)
Slipperiness		
Low slippery risk	NS	2,432 [1,831, 3,033]
Average slippery risk	−561 [−1,015, −113]	1,441 [861, 2,021]
Abrasion		
Low abrasion	NS	589 [77–1,100]
Average abrasion	−542 [−862, −261]	−452 [−926, 23]
Softness	NS	1,478 [797, 2,159]
Tenth year	947 [541, 1,353]	NS
Robotic scrapper	−359 [−715, −2]	−523 [−1,072, 26]
None	NS	−371 [−499, −6]

Estimates in parenthesis are 95 per cent confidence intervals. NS: Not significant Exchange rate in December 2019 (1 SEK: 0.096 Euro).
[a]The estimates are per square meters (m²) of alley and waiting area floor space with quality maintenance period of five to ten years.

4. Discussion and conclusions

In this paper, we examined how differences in the motivation of farmers to work with farm animal welfare affect their preferences for different flooring systems' attributes. Building on previous literature that emphasised that maximisation of financial outcomes may not be the sole motivation for farmers' decision-making, we set out to investigate the impact of use and non-use values as motivational constructs on preferences for attributes in animal welfare–related choices. Thus, the novelty of this paper lies in the incorporation of the use and non-use value motivational constructs into a choice framework by which we highlight how the constructs affect preferences for attributes, and thus how they affect choices. In doing so, this paper is among the first to demonstrate the application of use and non-use value motivational constructs in animal welfare exhibits on preferences and the fact that differences in the motivational construct thus transmit to the actual choice.

The findings indicate that advantage of the approach. Specifically, the findings demonstrate that dairy farmers who favour flooring solutions that enhance farm animal welfare are motivated by a complex set of both use values relating to internal and external pressures and non-use values linked to animal freedom, ethical codes of farmers and building business-to-customer relationships. This provides the rationale for the inclusion of the views of farmers in the formulation of animal health and welfare policies. It is also important to mention that inter-correlation between the use and non-use motivational constructs is found to play a significant role in explaining farmers' decision regarding flooring solutions.

With the use of the hybrid latent class model, we contribute new knowledge regarding the use and non-use value motivational constructs, especially about the identification of distinct dairy farmer segments with varied use and non-use motivational impacts. The variation of the utility estimates across classes for the same attributes suggests the presence of heterogeneity in dairy farmers' choice of flooring solutions. We found two distinct segments of dairy farmers, with one segment favouring soft floors and low abrasive floors with low-to-average slip risk and the other segment being indifferent towards the floors with the above-mentioned attributes. This is an important finding alluding to the need for a proper identification of distinct farmer groups for segment-specific animal welfare policies and the underlying structure of their motivational constructs. This suggests that future research should consider modelling approaches that enable the identification of farmer segments with distinct behaviour towards animal welfare.

The impact of farmer and farm characteristics on floor choice is worth some further discussion. Dairy farmers with agricultural education are more likely to prefer flooring solutions that enhance animal welfare. Engagement in off-farm employment positively correlates with preference for animal welfare–enhancing flooring solutions. This might be because the income obtained from off-farm work can be invested in farm management practices (income effect) that enhance animal health and productivity (Issahaku and Abdulai, 2020). Older farmers are more likely to have higher degrees of preference for improved flooring solutions, and this may be attributed to the fact that these farmers have observed the consequences and implications of different traditional flooring types such as solid concrete floors. Therefore, they are more willing to adopt improved floor solutions than young farmers who have little experience of the consequences of flooring systems.

Moreover, respondents who have experienced floor-related injuries and diseases and have reconstructed their barns tend to choose flooring solutions that enhance animal welfare, which also highlights how such preferences are shaped by experience. The findings also suggest that respondents with higher-yielding dairy cows have stronger preferences for animal welfare improvement flooring systems. The higher the farm income and household disposable income from dairy production, the more likely it is that the farmer will prefer flooring solutions that improve animal health and welfare. Investments in better floor is high in farms with higher productivity because of the higher management standards on those farms. The higher farm income from dairy production can enable the farmer to invest in better flooring solutions.

The implications of our findings about the impact of use and non-use values on farmers' preferences are important for policy and future research. First, our findings indicate that measures to stimulate more uptake of animal welfare improvement practices can be better targeted by using insights into use and non-use motivational constructs of dairy farmers in policy communication so that it alludes to the whole breadth of the motivational construct held by farmers. Future policy design, extension work and communications that seek to enhance farmers' use of farm animal welfare improvement practices can benefit from considering the farmer- and farm-specific factors identified to substantially affect the adoption of the practices in the dairy sector.

Future research interested in modelling farmers' behaviours in relation to the uptake of animal welfare improvement practices should rethink behavioural assumptions to accommodate use and non-use economic values and widen the farmers' scope to consider use and non-use economic values rather than focusing only on profitability and productivity attributes. Such recommendations can also be extended to cover more general models of farmer behaviour, i.e. such models would probably also be improved by allowing for behavioural motivation to centre not only on profitability and productivity concerns. The policy implications of this study are based on Swedish data. Hence, future research should investigate the impact on use and non-use values motivational constructs on choice in other settings and countries to further investigate the empirical significance and thus policy implications of those motivational constructs on choice.

Based on our findings, we conclude that use and non-use motivational values function to impact respondents' choice of animal welfare improvement practices. The decision of the dairy farmers surveyed appeared to be motivated by a complex set of both use and non-use values. Furthermore, dairy farmers seem not to be homogenous in terms of choice of flooring systems, exhibiting heterogeneous preferences. The dairy farmers are willing to offer substantial amounts of money for improvement in flooring attributes for the purpose of improving animal welfare. Moreover, these farmers are ready to pay money to avert changes that cause deterioration in the quality of floors.

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Supplementary data

Supplementary data are available at *ERAE* online.

Conflict of Interest

The authors declare that they have no conflict of interest.

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