How much do we actually care? A study on consumer preference heterogeneity and WTP for farm animal health and welfare in the UK

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Abstract

Do consumers care about the health of farm animals? We assess the relationship between consumer preferences (N=515), herd sickness levels and farm animal health and welfare (FAHW) by analysing UK consumers purchasing decisions, in the context of two endemic livestock conditions Bovine Viral Diarrhoea (BVD) in cattle and lameness in sheep. The analysis uses discrete choice experiments related to four products: beef and milk, and lamb and wool. Our study provides robust evidence that UK consumers care about farm animal health and welfare independently of the sickness level in the herd/flock, when sickness levels do not compromise the safety of the products consumed.

1. Introduction

In the ‘A new approach to consumer theory’, Kelvin Lancaster, (1966) laid the foundations to what is now a well-studied methodology of discrete choice experiments (DCE henceforth). Lancaster’s characteristics demand theory postulates that it is the characteristics of the goods in the basket rather than the goods itself that contribute to the utility consumers derive. Therefore, in our study we are looking at not the final product but the characteristics of these products and their relative significance to consumers when making purchases.

Product markets in the UK offer consumers a wide variety of products, such that we can pick and choose the product characteristics that most appeal to us. This study attempts to look at preferences for such product characteristics, contrasting attributes such as price and place of origin with animal health and welfare attributes. Importantly, we consider two livestock diseases where there is no link between prevalence and food safety or product quality. Our main research focus is on whether consumers have separable preferences for reductions in livestock disease relative to broader animal welfare considerations, since "farm animal welfare" is a much broader concept than livestock disease status. We compare preferences for these attributes across four animal products, beef steak and milk from cattle and lamb chops and pure wool from sheep.

We use Bovine Viral Diarrhoea (BVD) and lameness as reference conditions in the study. BVD is a highly contagious viral disease that spreads as easily as common cold. There are two types of infections caused by this disease a transient infection and a persistent infection. Transient infections are temporary. They are characterised by poor fertility, low production of milk and immunosuppression which makes cattle more susceptible to diseases. This type of infection is caused after the birth of a cattle. On the other hand, a persistent infection is a lifelong infection where cattle are born with the disease. Most die within 18-24 months and during their life spread the virus infecting cattle that come in contact with them. BVD can be spread from infected dams to unborn calves, through direct contact with infected animals, indirectly by visitors or contaminated equipment and through the semen from infected bulls. The economic costs are estimated at £61 million per year at the national level (Bennett and Ijpelaar, 2005).

Lameness is one of the most widespread and persistent welfare in the UK sheep flock. It is a significant cause of discomfort and pain as well as a major source of economic loss to the farmer as well as the sheep industry. The estimated cost to the sheep industry is £80-£85 million per year (Winter and Green, 2017). The causes of lameness are widespread ranging from infections to environmental conditions (Winter, A. 2004).

These conditions both lameness and BVD are a source of numerous health complications throughout the life of the animals, leading to early death in the case of BVD[1] as well as tremendous economic costs (Gunn et al., 2005). The characteristics of these diseases make them apt objects for study. However, consuming animal products from sheep and cattle affected by these conditions induces no adverse health effects in consumers. This led us to ask the question whether consumers

[1] See https://bvdfree.org.uk/the-disease/ for more information on the BVD.

care about the sickness level of farm animals independently of the overall animal welfare grading assigned to the farm. Do people care about sickness levels in farm animals when such sickness has no direct implications for food safety?

The remainder of this paper has been organised as follows. Section 2 reviews some of the literature in the area. Section 3 details the methodology which includes the data, variables and the econometric analysis. Section 4 presents our main findings and section 5 discusses and concludes.

2. Literature review

In recent years, there have been extensive debates regarding animal health and welfare. Our research aims to contribute to this ever-growing literature on animal welfare in livestock production. This topic has gained much attention not only amongst directly interested groups such as the members of the food production industry (for instance, meat producers and retailers) but also in a broad range of academic disciplines.

Animal welfare has been defined in several contexts with scientific, economic and ethical perspectives emphasizing different aspects of the concept. Farm animals, for the most part, are treated as valuable commodities so that welfare levels are established by the demands and preferences of our society (McInerney, 1998). This view is also shared by Webster (2001) who defines farm animal welfare as an animal's ability to sustain fitness and avoid suffering. The author argues that the responsibility of the farmer is to make provision for good welfare through good husbandry; he cannot ensure “good welfare". Webster claims, therefore, that the consumer is responsible for welfare outcomes since she is the one expressing a desire for higher welfare standards. In this regard, Webster argues in favour of a free-market approach that places value on farm animals through consumer demand, thus ensuring their welfare. This explains the reasoning behind the different care for the treatment of pets as opposed to a cow for example, at the end of her milking period. The market determines what is acceptable and what is not. Although most countries also impose regulatory standards which set minimum requirements for farm animal welfare; consumer demands can raise welfare above these regulatory standards (minimum requirements), but not below. Thus, the market defines the acceptable threshold of suffering.

Generally, what is acceptable treatment to cows, for example may be deemed unacceptable for companion animals (pets).

Nevertheless, the interpretation of farm animal health and welfare varies substantially amongst different types of market participants and also the way it is perceived is greatly affected by the group's (or individual's) belief system, ethics, customs, awareness and motives. Consumers frequently associate the farmers' interest in animal welfare as being solely returns motivated with their own concerns being ethically driven but this may well be over-simplification of farmer motives.

Latacz-Lohmann and Schreiner, (2019) look at both the farmer as well as consumer preferences for farm animal welfare reported consumers' willingness to pay to be significant in several aspects of animal welfare including less surgical interventions, more space per pig, more bedding and shorter transportation.

Literature have also attempted to classify behaviour by dividing consumer preferences for food into two quality attributes: extrinsic credence cues and intrinsic search cues (Zanoli et al., 2013). Intrinsic credence cues are related to the physical aspect of the products which could include price, colour and visible fat whilst credence attributes include animal welfare, country of origin, environmental impact etc. Credence attributes are not directly observable to the consumer. For classification purposes our study utilizes three credence and one search attribute. It has also been argued that consumer choices may be influenced by food category (Maehle et al., 2015). The authors make a distinction between food consumed for pleasure versus that for nutritional value. They find that price and taste were significant for both hedonic and utilitarian products. This result becomes even more compelling when consumers are grouped by their product preferences with environmental friendliness and healthfulness being more important to health conscious and environmentally conscious segments of the society.

Drawing from the existing literature, our study investigates consumer preferences and WTP for farm animal health and welfare using a combination of hedonic and utilitarian goods with search and credence cue attributes. We seek to understand the extent to which consumers are willing to trade-off one attribute against the other, and their willingness to pay for increases in desired attributes. The key distinction we make is the separation of animal health from animal welfare.

3. Methodology

3.1 Experiment design and data

We use a discrete choice experiment for the empirical analysis on 515 UK consumers. The survey was conducted in July 2020. Qualtrics, a market research company was commissioned to collect the data in a manner that ensured the representatives of the sample according to geographical distributions and some major demographic characteristics of the UK population. The online choice experiment survey was developed using Sawtooth software and the experimental design was generated in NGene. Prior to running the main survey, a pre-test and two pilot surveys were conducted. The pre-test involved small focus groups and on-line interviews with members of the public that provided us with qualitative data. This data along with existing literature fed into the identification of the attributes and its levels. The first pilot was used to troubleshoot any issues with the survey. The second pilot of n = 48 with a D-efficient design with zero priors. This facilitated the generation of the final choice sets that incorporated a homogenous Bayesian efficient design.

The survey included four choice sets, one for each product (Cattle product:-beef steak, milk and Sheep product:- lamb chops and pure wool). Each respondent received two choice sets combining a product from each animal, together with questions that sort information on socio-demographics with the intention to use them to determine their effects on the preferences. In the survey, respondents were produced with short summaries on the two infections prior to starting the choice experiment. Importantly, respondents were told that "*These diseases/conditions may undermine farm animal health and welfare. However, they do not cause any ill effect to humans when they consume the animal products*." It is important to emphasize here that we reiterated several times throughout the experiment that "*all the products displayed in the choice scenarios were completely safe to consume.*" These choice sets comprised six choice cards with each choice card having three alternatives, two products and one opt out. The experimental design was composed of three blocks of six choice scenarios each. The respondents have to choose one of these alternatives. Vegetarian respondents were limited to milk and wool choice sets. An example choice card is displayed in figure 1. The choice cards for milk, lamb chops and wool followed a similar design.

Which of the following three options of beef steak (500 grams) would you choose?

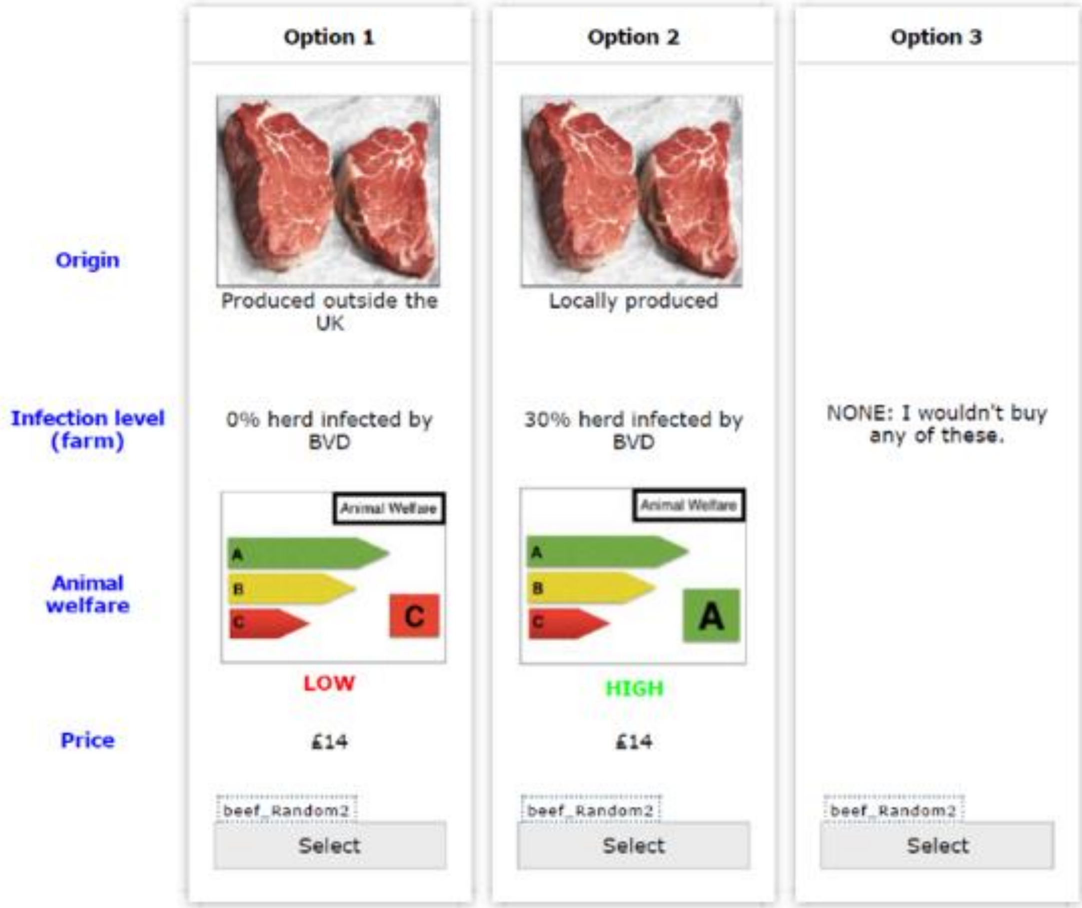

Figure 1. An example choice card for beef

The attributes in the choice sets (origin, animal welfare grading, herd infection level for BVD or lameness as appropriate, and price), along with the levels for each of the four attributes are summarised in table 1. These attributes were chosen based on literature and the question at hand.

I. <u>Price levels</u> - This pecuniary attribute determined based on the current market prices in budget chain supermarkets, premium supermarkets and private butchers' shops.
II. <u>Origin</u> – Product origin was used as a proxy for food mileage/traceability distinguishing products produced locally, within the UK and outside the UK. R. Zanoli et al., (2013) found domestic breed origin as one of the most important attributes to the Italian sample. Country of origin was found to be the most requested attribute in Cicia and Colantouni.,

(2010), in their meta-analysis for WTP on meat traceability along with food safety and animal welfare playing a crucial role. We do not look at breeds nor specific countries but at the place of production. For example, locally produced suggested the product came from less than 50 miles from where the consumer purchases the product; produced elsewhere in UK indicated the product is produced within the UK but outside the 50 miles radius; and produced outside the UK indicates an imported product.

III. Animal welfare grading- This attribute grades the product as coming from a high, medium or low welfare farm that distinguishes farms based on the overall quality of the farm. Our experiment uses an ecolabel scale from A-C sorting animal welfare from highest to lowest with C being the base in our estimation signifying lowest welfare while A signifying highest welfare. We imposed the assumption that animal welfare grading could be based on a certification by any trusted organisation such as Red tractor, RSPCA etc. Animal welfare is a fairly well-established attribute of importance for consumers. However, what animal welfare means differs widely, with previous work using different proxies to measure it. In Zanoli et al., (2013), they looked at whether the cattle were "allowed to range freely or were they confined and chained?" as their proxy for animal welfare and found that animal welfare did play a role in influencing consumers when making organic meat purchases. This study, however, did not use a representative sample. Caracciolo et al., (2010) in their paper showed that generally European consumers seem to take account of animal welfare attribute more than other intrinsic product characteristics. Osch et al., (2017) used ecolabels to indicate sustainability levels in their study on Irish publics willingness to pay. This paper was the source of inspiration for the welfare gradings used on our study.

IV. Herd/flock infection level – This attribute specifies the prevalence rates for BVD or lameness in the herd/flock that the product comes from.

Table 1: Attributes and their levels in the choice experiment

Attributes	Description	Levels	
Price	Beef steak (fillet)	£11, £14, £19	500 grams i.e. 2 steaks
	Milk	£0.44, £0.70, £1.15	1 litre= 0.75 pints
	Lamb chops	£4, £6.50, £9.50	500 grams
	Wool (pure)	£6.50, £12, £18	100 grams
Animal welfare (Grading)	High	A	
	Medium	B	
	Low	C	
Infection level in the herd	Beef steak	0%, 10%, 20%, 30%	BVD
	Milk	0%, 10%, 20%, 30%	BVD
Infection level in the flock	Lamb chops	0%, 10%, 20%, 30%	Lameness
	Wool (pure)	0%, 10%, 20%, 30%	Lameness
Origin		Locally produced	<50 miles from shop
		Produced elsewhere in the UK	
		Produced outside the UK	

Table 2
Socio-demographic characteristics of the respondents

Variables	Sample n = 515	Beef n = 242	UK Population
Share of males	0.47	0.54	0.49
Average family size	2.67	2.67	2.3
Age (years)			
18 – 24	0.12	0.13	0.11
25 - 34	0.18	0.13	0.17
35 - 44	0.17	0.17	0.16
45 - 54	0.20	0.22	0.19
55 and over	0.31	0.32	0.37
Age (mean)	45 years	46 years	
Age (median)	50 years	50 years	40 years
Age (mode)	50 years	50 years	
Education level			
Median	A-levels or advance GVNQ or equivalent	A-levels or advance GVNQ or equivalent	41% adults have college degrees
Mode	Undergraduate degree	Undergraduate degree	
Income distribution (monthly after tax)			
Median	£2001 – £2500	£2001 - £2500	£1700
Mode	£1001 - £1500	£1001 - £1500	
Cov19 impact on expected future earnings	No = 0.68 Yes = 0.32	No = 0.66 Yes = 0.34	

Note: The statistics for the UK population are from ONS (Office of National Statistics) and the UK 2011 census.

Table 2 summarises the demographic characteristics of our sample and compares them across the UK population. It is worth noting here that the UK population census was last conducted nearly 10 years ago so we expect variations in the statistics. Table B1 in the appendix includes the demographics for the lamb, wool and milk samples. Overall, our sample is representative of the UK population. Men made up 47% of the sample. The age distribution matched that of the UK except for consumers over 55 years where our sample had 31% compared to the UK population of 37%. The average family size was 3 persons. The median education level is A-levels or equivalent with the modal education level being an undergraduate degree.

3.2 Econometric estimation

It is presumed the respondent chooses the option that is likely to give them the highest utility. To account for heterogeneity in preferences we include a random component within utility, alongside observable components of choice such as the characteristics of products, and the socio-economic characteristics of people (Hensher, Rose, Greene, 2003).

The preferences we intend to model are an ordinal property of preferences in that they only provide us with the relative ranking for the set of alternatives we model. The main focus in developing this model is to explore causes of heterogeneity in the respondents' observed and unobserved influences in decision making. In order to formalize choice situations, we then define a utility function with the aim to maximise utility.

Let U_{isj} be the utility for individual i in choice situation s given alternative j. This utility is a sum of a deterministic i.e., observable component V_{isj} that depends on the regressors, the unknown parameters β and the unobserved random component $\in_{isj}$. This can be represented by a standard random utility expression:

$$U_{isj} = V_{isj} + \in_{isj} \qquad 1$$

We can go further and conclude that the probability of alternative j being selected is given by the following:

$$\Pr(y_i = j) = \Pr\left(U_{isj} > U_{isk}\right) \qquad 2$$

$$= \Pr\left(U_{isj} - U_{isk} > 0\right) \qquad 3$$

Which implies that

$$\Pr\left(V_{isj} - V_{isk}\right) + (\in_{isj} - \in_{isk}) \ > 0\Big) \qquad \forall\, k \neq j \qquad 4$$

Essentially translates to the probability that the difference in the random components is less than the difference in the deterministic components. We can then claim that it is only the differences in the utility that really matter.

The random parameter logit (RPL) model has been developed as one method of allow for unobserved heterogeneity of preferences (Train, 2009). Preference heterogeneity in the sample is incorporated into the model by treating the coefficients as random rather than fixed allowing attribute coefficients to vary across respondents, thus improving the realism of the model and interacting consumer characteristics with the constant (opt-out) given that these do not vary across alternatives (Hanley et al., 2001). The random parameters model, or the mixed logit model relaxes the IIA assumption by allowing its parameters to be normally distributed. We also assume that these random parameter distributions are continuous over the sample. More than one parameter can be treated as random which contributes to the practicality of such models. Therefore, we find that the choice probabilities now depend on the random parameters.

We define the probability of choice as $\Pr\left(Y_{ij} = j\right) = \frac{\exp\,(V_{isj})}{\sum_{j=1}^{jsi} \exp\,(V_{isj})}$ 5

Where $V_{isj} = \beta_i' x_{isj} + a_j$

The model therefore takes the form:

$$\beta_{ik} = \beta_k + \Delta z_{ik} + \gamma \vartheta_{ik} \quad (6)$$

$$\alpha_{ij} = \alpha_j + \Delta_j z_j + \gamma \vartheta_{ij} \quad (7)$$

α_j is the generic constant, x_{isj} are the K attributes of alternative j pertaining to individual i, in choice situation s, z_i are the set m aspects of individual i, a vector of k random variables, with mean zero, unit variance and zero covariance is given by ϑ_{ik}. Heterogeneity of choice specific constants, with normal distribution is represented by ϑ_{ij} and finally β_k is the k-attribute coefficients of the population mean. where the individual-specific preference parameters β and the choice specific constants α are not _xed for all the respondents but vary around their means.

Using the coefficient from both models, we derive the willingness to pay (WTP) estimates as a ratio of the coefficients of the attribute variables and the price variable.

$$WTP_x = -\frac{\beta_x}{\beta_{price}}$$

This gives us the marginal values of the attribute levels from preferences elicited of each respondent. These estimates shed light on consumers utility for changes in attribute levels. Confidence intervals were also estimated using the delta method and by non-parametric bootstrapping since we model price as a random variable (Hole, 2007).

4. Results

The analyses were conducted for each of the four products using conditional logit and random parameter logit regressions. The model results are reported in tables 3 and 4 for beef: results for the other products can be found in the appendix table B1, B2, B3, and are largely qualitatively similar to the beef results.

All our attribute coefficients for beef were found to be statistically significant. Using a sample of 242 respondents we estimated multinomial logit models as presented in table 3. These indicate that any increase in the animal welfare is preferred by our respondents. Relative to low welfare (grade C), our estimates show positive and statistically significant effect on the UK consumers utility for increases in animal welfare. An increase in animal welfare from grade C (low welfare) to grade B (medium welfare) has a positive coefficient with the magnitude rising further as the grade goes up to A (high welfare).

When it comes to the origin of the product, consumers showed a strong preference for beef products produced within the UK compared to our base level of beef produced outside the UK. This result was even stronger for locally produced beef than for beef that originated within the UK but greater than 50 miles from their place of purchase indicating a strong preference for close proximity of production.

The attribute for BVD infection level was also found to be statistically significant and negatively increased in magnitude given that the base level was zero infection rate indicating that consumers preferred the beef product coming from farms with a lower prevalence of infection, given a constant rating of farm animal welfare.

The negative parameter estimate for monetary attribute price was in line with theory. Unsurprisingly, higher price of beef yielded lower utility. The coefficient for price indicated a negative relationship between consumer choice and price.

The alternative specific constant represents the opt out option where consumers have the option to choose purchasing neither of the products offered. This parameter was found to be negative and statistically significant indicating that people in our sample on average preferred to not opt out of the purchase.

The model includes demographic variables interacted with the opt out option including place of residence, country of residence, age, disposable income, education, gender, family size, number of children under the age of 18 and any expected changes in future income. Interacting these variables with status quo tells us the likelihood of choosing the opt out option by a specific demographic. Our model suggests that male respondents are more likely to purchase beef steak as presented in the choice experiment. Similarly, respondents with higher education level and higher income[2] choose making a purchase instead of opting out. Interestingly, we find that older respondents are more likely to opt out. Number of kids underage, family size and residency were found to be statistically insignificant.

Table A1 in the appendix shows the estimation results using consumer socio-demographic backgrounds. Older consumers appear to be less likely to choose beef that has some prevalence of infection. However, they also show low preference for high welfare beef.

[2] Income here refers to average income per household. Given income, household size we believed average income would give a better indication of wealth distribution.

Table 3: Estimation results for Conditional Logit Model with attribute level-dummy variable- Beef

Beef Variable	Coefficient
Opt-out	-2.084*** (0.474)
Price	-0.101*** (0.0142)
Animal Welfare (Base level = Low)	
High Welfare = 1	0.834*** (0.109)
Medium Welfare = 1	0.513*** (0.121)
Origin (Base level = Produced outside the UK	
Locally Produced = 1	0.663*** (0.107)
Produced elsewhere in the UK = 1	0.201* (0.112)
Infection level (Base level = 0%)	
10% infection in the herd	-0.879*** (0.112)
20% infection in the herd	-1.146*** (0.132)
30% infection in the herd	-1.598*** (0.117)
Interactions with Opt-Out alternative	
Age	0.0223*** (0.00401)
Income (average per household)	-0.000209** (9.61e-05)
Education	-0.121* (0.0662)
Male	-0.208* (0.122)
Type of residences (Base level = Urban with significant rural)	
Urban residents	0.224 (0.166)
Rural residents	-0.119 (0.188)
Number of children below 18 years	-0.189** (0.0843)
Change in expected future income	-0.0206 (0.129)
England	0.0777 (0.316)
N. Ireland	-0.505 (0.629)
Scotland	0.110 (0.385)
Information criteria	
Number of observations	4,356
Number of respondents n	242
Log-likelihood	-1395
AIC	2830.025
BIC	2957.612

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 indicate significance.

Table 4 lists the results of the random parameter logit (RPL) model. Models 2, 3 and 4 are presented as a contrast to the main effects base model. These models capture the effects of socio-demographic characteristics. All attributes were specified as having a random component. All our attribute variables were found to be statistically significant showing a similar pattern to the models specified in the conditional logit model showing clear preferences. Price, opt out and high infection rates showed negative preferences whilst beef from within the UK and more specifically locally produced beef was found to have a positive preference. Preferences for animal welfare were positive and increased from grade C to A that is from low to high animal welfare indicating that high welfare was important to consumers when determining which product to buy.

These models also take into consideration preference heterogeneity. The estimated standard deviations for the attribute variables were all found to be statistically significant with exceptions for 30% infection rate in specifications (2), (3) and (4). This suggests that there is significant individual heterogeneity in attitudes towards purchasing beef. The preferences for origin, animal welfare and infection level vary across the population. Adding demographic variables in models (3) and (4) reduces the heterogeneity in infection level but the random taste variation remains in other attributes. Respondents that were male and those with high income we were less likely to choose the opt out option, whereas older consumers were less likely to choose purchasing beef given the presented options. We also find that respondents who had a higher number of children under the age of 18 preferred making the purchases as presented.

To compare model fit we looked at the Akaike Information Criteria (AIC), Bayesian Information Criterion (BIC) and the log-likelihood for each of the models. The AIC and BIC for RPL models (2242 and 2356 respectively) are lower than for the MNL model (2830 and 2957, respectively). As for the log-likelihood the RPL models (-1103) have higher log-likelihood than the MNL models (-1395). All three of the information criteria indicate the RPL models are preferred over the MNL models.

Table 4

Estimation results from Random Parameter Logit model- Beef

	(1)		(2)		(3)		(4)	
	β (SE)	Standard deviation	β (SE)	Standard deviations	β (SE)	Standard deviations	β (SE)	Standard deviations
Random parameters								
Opt-out	-5.070***	4.838***	-6.288***	4.762***	-5.331***	4.206***	-8.661***	5.618***
	(0.618)	(0.597)	(2.275)	(0.729)	(0.651)	(0.521)	(2.212)	(0.840)
Price	-0.269***	0.190***	-0.281***	0.233***	-0.108	0.229***	-0.282***	0.254***
	(0.036)	(0.040)	(0.0370)	(0.0411)	(0.0676)	(0.0315)	(0.0962)	(0.0386)
Animal Welfare (Base level = Low)								
High Welfare = 1	1.992***	2.248***	1.908***	2.019***	3.099***	2.167***	3.877***	2.166***
	(0.295)	(0.302)	(0.297)	(0.321)	(0.756)	(0.307)	(0.849)	(0.297)
Medium Welfare = 1	1.295***	-1.202***	1.158***	0.931**	1.442**	-1.067***	2.046***	1.118***
	(0.252)	(0.394)	(0.235)	(0.415)	(0.645)	(0.357)	(0.735)	(0.396)
Origin (Base level = Produced outside the UK								
Locally Produced = 1	1.442***	0.035	1.391***	0.0488	1.399**	0.635*	1.176*	0.279
	(0.239)	(0.905)	(0.243)	(0.413)	(0.623)	(0.351)	(0.665)	(0.466)
Produced elsewhere in the UK = 1	0.835***	1.498***	0.803***	1.610***	0.808	1.251***	1.012	1.518***
	(0.266)	(0.394)	(0.285)	(0.407)	(0.693)	(0.366)	(0.783)	(0.372)
Infection level (Base level = 0%)								
10% infection in the herd	-2.059***	0.740**	-1.956***	-0.662*	-1.701***	-0.661*	-2.226***	-0.878**
	(0.260)	(0.332)	(0.243)	(0.380)	(0.592)	(0.382)	(0.665)	(0.346)
20% infection in the herd	-2.697***	1.823***	-2.512***	1.460***	-1.776**	1.411***	-2.829***	-1.665***
	(0.383)	(0.451)	(0.340)	(0.460)	(0.777)	(0.471)	(0.923)	(0.404)
30% infection in the herd	-3.876***	1.385***	-3.576***	1.159***	-2.921***	0.848**	-3.603***	-1.418***
	(0.433)	(0.366)	(0.372)	(0.350)	(0.690)	(0.419)	(0.811)	(0.409)
Interactions with Age								
Age*locally produced					-0.00001		0.00848	
					(0.0120)		(0.0129)	
Age*produced elsewhere in the UK					0.00127		0.00118	
					(0.0140)		(0.0157)	
Age*high welfare					-0.0280*		-0.0395**	
					(0.0145)		(0.0162)	
Age*medium welfare					-0.00607		-0.0170	
					(0.0132)		(0.0146)	
Age*10% infection in the herd					-0.00493		0.00330	
					(0.0117)		(0.0130)	
Age*20% infection in the herd					-0.0157		0.00448	
					(0.0158)		(0.0181)	
Age*30% infection in the herd					-0.0128		-0.00667	
					(0.0134)		(0.0155)	
Age*price					-0.00360***		-0.000220	
					(0.00135)		(0.00197)	
Interactions with Opt-Out alternative								
Age			0.0544**				0.0434	
			(0.0247)				(0.0342)	
Income (average per household)			-0.00117				-0.000579	
			(0.000729)				(0.000433)	
Male			-0.865				-0.657	
			(0.732)				(0.652)	
Education			-0.318				-0.251	
			(0.315)				(0.319)	
Type of residences (Base level = Urban with significant rural)								
							-0.417	
							(0.894)	
Urban residents								
			-0.470				-0.383	
Rural residents			(1.222)				(1.075)	
			-0.0746				-1.450***	
			(0.904)				(0.477)	

	(1)	(2)	(3)	(4)
Number of children below 18 years		-0.767		-0.0466
		(0.541)		(0.670)
Change in expected future income				3.413**
		0.248		(1.463)
England		(1.375)		-0.108
				(2.566)
		1.483		2.681
N. Ireland		(1.965)		(1.653)
Scotland		-2.076		
		(3.048)		
Information criteria		0.260		
		(2.408)		
Number of observations	4,356	4,356	4,356	4,356
Number of respondents	242	242	242	242
Log-likelihood	-1103	-1099	-1101	-1087
AIC	2242.165	2255.604	2254.808	2247.525
BIC	2356.992	2440.604	2420.67	2483.559

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 indicate significance.

Next, we calculated the marginal willingness to pay (WTP) for discrete changes in the levels of each attribute. Results are shown in Table 5. Since we have attribute level dummies, the WTP in this case can be interpreted as the price for a change from the base attribute level to an alternative level. The table includes the confidence intervals for WTP estimates for the conditional logit model (1) using the delta method whilst the random parameter logit model (2) model used a non-parametric bootstrapping procedure. Both models have coefficients similar in size and sign.

Table 5

Marginal willingness to pay: Beef

	(1) Conditional Logit Model	Beef	(2) Random Parameter Logit Model	
Variable	WTP (£ per unit change from the attribute)	WTP (95% Confidence interval)	WTP (£ per unit change from the attribute)	WTP (95% Confidence interval)
High Welfare = 1	8.29	[5.85; 10.72]	6.99	[5.06; 8.91]
Medium Welfare = 1	5.10	[2.83; 7.35]	4.55	[2.91; 6.20]
Origin (Base level = Produced outside the UK				
Locally Produced = 1	6.59	[3.62; 9.55]	5.03	[2.99; 7.06]
Produced elsewhere in the UK = 1	2	[-0.260; 4.25]	2.61	[0.67; 4.54]
Infection level (Base level =30%)				
0% infection in the herd	15.87	[11.18; 20.55]	13.43	[10.08; 16.78]
10% infection in the herd	7.14	[4.24; 10.04]	6.06	[4.13; 7.99]
20% infection in the herd	4.48	[1.06; 7.90]	3.23	[0.65; 5.80]

Note values are rounded to two decimal places. The estimates are for £ per 500 grams of beef fillet steak.

An increase in animal welfare leads to an average marginal value of £5.10 for medium welfare product and £8.29 for high welfare product per 500 grams for the conditional logit model. Whilst the random parameter logit model WTP estimates indicate that the UK consumer has a WTP of £4.64 per 500 grams for a medium welfare and £6.98 per 500 grams for high welfare beef steak. Both models indicate consumers are willing to pay the most for beef with 0% infection in the herd. A high value £15.87 per 500 grams was found for beef coming from farms with no infection at all according to model (1) and £13.44 per 500 grams according to model (2). This WTP decreases as the prevalence of infection in the herd increases. Beef from farms with 10% infection in their herd had marginal WTP of £7.14 per 500 grams in model (1) and model (2) estimated this value as £5.81 per 500 grams. On the other hand, farms with 20% prevalence of infection in model (1) had values at £4.48 while model (2) estimated these to be £3.50 per 500 grams. The WTP for beef produced elsewhere in the UK is at the lower end of the range of WTP for both models. Generally, both models show comparable results given that their confidence intervals overlap for all attributes. We report the willingness to pay across all products in table 7.

In Table 6, assuming a normal distribution for random parameters we calculate the proportion of respondents for whom a beef attribute has a positive or negative effect on preference for purchasing that product. It seems that every responded in our sample prefers consuming locally sourced beef.

Table 6

Random Parameter Logit model and standard deviations with calculated proportions of positive/negative preference for beef attributes

	β (SE)	Standard deviation	% proportion for preference
Animal Welfare (Base level = Low)			
High Welfare = 1	1.992***	2.248***	81.0
	(0.295)	(0.302)	
Medium Welfare = 1	1.295***	-1.202***	85.8
	(0.252)	(0.394)	
Origin (Base level = Produced outside the UK			
Locally Produced = 1	1.442***	0.035	*100
	(0.239)	(0.905)	
Produced elsewhere in the UK = 1	0.835***	1.498***	20.9
	(0.266)	(0.394)	
Infection level (Base level = 0%)			
10% infection in the herd	-2.059***	0.740**	-49.7
	(0.260)	(0.332)	
20% infection in the herd	-2.697***	1.823***	-14.8
	(0.383)	(0.451)	
30% infection in the herd	-3.876***	1.385***	
	(0.433)	(0.366)	-49.7
Information Criteria			
Number of observations	4,356		
Number of respondents	242		
Log-likelihood	-1103		
AIC	2242.165		
BIC	2356.992		

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 indicate significance

Table 7

Marginal Willingness to pay across all products

	Beef (500 grams) (1)	Milk (0.75 pints) (2)	Lamb (500 grams) (3)	Wool (100 grams) (4)
	WTP (95% CI)	WTP (95% CI)	WTP (95% CI)	WTP (95% CI)
Animal Welfare (Base level = Low)				
High Welfare = 1	6.98***	0.69***	2.92***	14.31***
	[4.01; 9.95]	[0.49; 0.89]	[1.72; 4.12]	[9.66; 18.95]
Medium Welfare = 1	4.64***	0.34***	2.00***	8.11***
	[2.77; 6.52]	[0.25; 0.44]	[1.47; 2.54]	[5.84; 10.39]
Origin (Base level = Produced outside the UK				
Locally Produced = 1	5.04***	0.57***	1.59***	7.99***
	[1.45; 8.64]	[0.21; 0.94]	[0.80; 2.37]	[3.78; 12.20]
Produced elsewhere in the UK = 1	3.04*** [0.60; 5.18]	0.54*** [0.30; 0.78]	1.57*** [0.49; 2.66]	6.45*** [4.38; 8.52]
Infection level (Base level = 30%)				
0% infection in the herd	13.44***	1.13***	4.01*** [2.60; 5.42]	20.38*** [8.06, 32.69]
	[7.31;19.57]	[0.86; 1.40]		
10% infection in the herd	5.81*** [4.65; 6.97]	0.5*** [0.26; 0.76]	1.76*** [1.04; 2.48]	11.19*** [4.63; 17.75]
20% infection in the herd	3.50*** [0.59; 6.41]	0.48*** [0.11; 0.85]	1.22*** [0.50; 1.94]	9.55*** [5.63; 13.46]
Information criteria				
Number of observations	4,356	4,914	4248	5,022
Number of respondents	242	273	236	279
Log-likelihood	-1103	-1587	-1031.54	-1663

Note values are rounded to two decimal places. Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 indicate significance

5. Discussion

In this paper, we investigated UK consumer preferences and willingness to pay for farm animal health and welfare using 4 different animal products.

The study provides robust evidence that the UK public cares about the sickness level of the animals even when controlling for variations in animal welfare as well as other characteristics like place of production and price. This is interesting, as respondents were given strong reassurance that the products were completely safe to consume regardless of the infection level. Thus, consumers seem to care about sickness levels in farm animals even when this has no consequences for food or product safety. This finding is particularly relevant given recent statements by DEFRA[3] on the direction of public funding for farming post-Brexit, where farm animal health is seen as something which taxpayers should contribute to (since it can be argued to have some public good characteristics).

Additionally, we have also found that the value placed on high animal welfare and low infection rates varies with the participants' age and income. Younger consumers value high animal welfare and low infection rates more than older consumers despite the fact that their the average income of their household tends to be lower. Higher income consumers, ceteris paribus, showed a greater preference for high animal welfare. There was, however, significant un-observed preference heterogeneity in the findings despite the inclusion of possible observed sources of such variation like age, income, and education.

According to Kendall et al., (2006), producers have a tendency to perceive themselves as rational (well-informed) agents, whilst they immediately reject the fears of the general public labelling them too sensitive and uninformed. On the other hand, consumers frequently associate the farmers' interest in animal welfare as being solely returns motivated with their own concerns being ethically driven. These concerns were further echoed in the outcomes of the study by Vanhonacker et al., (2008) where consumers typically attribute higher weight compared to farmers when evaluating the significance of farm animal welfare.

[3] See "The Path to sustainable farming: An Agricultural Transition Plan 2021 to 2024". https://www.gov.uk/government/publications/agricultural-transition-plan-2021-to-2024

During a recession especially as unpredictable as the ongoing pandemic has been, it is period of very high uncertainty. People are worried about their expected future income and although the majority of our sample (roughly 66 %) still retained their optimism, it is very interesting to see that still prioritise locally produced, disease free, high welfare products instead of substituting this consumption good with inferior substitutes.

These results are particularly interesting given we collected this data during the ongoing COVID19 pandemic. In a period where people are very uncertain about their future earnings, they still show this WTP for improving animal health and welfare.

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7. Appendix

Table A1

Summary statistics

Variables	Lamb n = 236	Milk n = 273	Wool n = 279
Share of males	0.48	0.50	0.48
Average family size	2.72	2.66	2.62
Age (years)			
18 – 24	0.14	0.11	0.11
25 - 34	0.15	0.23	0.21
35 - 44	0.18	0.18	0.18
45 - 54	0.20	0.18	0.20
55 and over	0.33	0.30	0.29
Age (mean)	45 years	44 years	44 years
Age (median)	50 years	40 years	40 years
Age (mode)	50 years	30 years	30 years
Education level			
Median	A-levels or advanced GNVQ or equivalent	A-levels or advanced GNVQ or equivalent	A-levels or advanced GNVQ or equivalent
Mode	Undergraduate degree	Undergraduate degree	Undergraduate degree
Income distribution (monthly after tax)			
Median	£2001 – £2500	£2001 – £2500	£2001 – £2500
Mode	£1001 – £1500	£1001 – £1500	£1001 – £1500
Cov19 impact on expected future earnings	No = 0.66 Yes = 0.34	No = 0.70 Yes = 0.30	No = 0.70 Yes = 0.30

Table B1: Random Parameter Logit specifications for milk (Age and education)

VARIABLES	(1)	Standard deviations	(2)	Standard deviations	(3)	Standard deviations
Age	0.00416					
	(0.0202)					
Income	8.60e-05					
	(0.000335)					
Male	-1.674**					
	(0.784)					
Education	-1.169***					
	(0.441)					
Type of residences (Base level = Urban with significant rural						
Urban residents	0.503					
	(0.732)					
Rural residents	0.407					
	(0.943)					
Number of children below 18 years	-0.327					
	(0.348)					
Change in expected future income	0.539					
	(0.748)					
England	-1.326					
	(1.564)					
N. Ireland	-1.459					
	(2.047)					
Scotland	-0.876					
	(1.774)					
Vegetarian	2.646***					
	(0.721)					
Opt-out	0.112	4.003***	-3.585***	4.512***	-3.592***	4.321***
	(2.415)	(0.558)	(0.509)	(0.609)	(0.464)	(0.501)
Price	-2.345***	3.099***	-2.407***	3.142***	-2.290***	3.076***
	(0.364)	(0.408)	(0.369)	(0.501)	(0.338)	(0.404)
Animal Welfare (Base level = Low						
High Welfare = 1	1.736***	2.237***	3.100***	2.294***	2.166***	2.145***
	(0.250)	(0.291)	(0.644)	(0.350)	(0.326)	(0.266)
Medium Welfare = 1	0.779***	-0.381	1.494***	-0.387	1.249***	0.00487
	(0.192)	(0.324)	(0.550)	(0.435)	(0.260)	(0.490)
Origin (Base level = Produced outside the UK						
Locally Produced = 1	1.601***	-1.212***	1.620***	-1.321***	1.566***	-1.099***
	(0.246)	(0.337)	(0.250)	(0.352)	(0.222)	(0.346)
Produced elsewhere in the UK = 1	1.407***	-0.355	1.465***	-0.168	1.359***	-0.684*
	(0.234)	(0.860)	(0.250)	(0.540)	(0.225)	(0.407)
Infection level (Base level = 0%)						
10% infection in the herd	-1.518***	-1.078***	-1.563***	1.204***	-1.564***	-0.910***
	(0.219)	(0.343)	(0.582)	(0.326)	(0.274)	(0.347)
20% infection in the herd	-1.491***	1.518***	-1.213*	1.592***	-1.898***	-1.482***
	(0.273)	(0.384)	(0.735)	(0.388)	(0.359)	(0.325)
30% infection in the herd	-2.930***	-1.429***	-3.354***	1.527***	-2.944***	-1.483***
	(0.314)	(0.351)	(0.674)	(0.326)	(0.342)	(0.315)
Interactions with Age						
Age*high welfare			-0.0292**			
			(0.0131)			
Age*medium welfare			-0.0158			
			(0.0114)			
Age*10% infection in the herd			-0.00129			
			(0.0116)			
Age*20% infection in the herd			-0.00773			

		(0.0152)	
Age*30% infection in the herd		0.00696	
		(0.0123)	
Male*high welfare			-0.915**
			(0.402)
Male*medium welfare			-0.828**
			(0.343)
Male*10% infection in the herd			0.134
			(0.339)
Male*20% infection in the herd			0.636
			(0.449)
Male*30% infection in the herd			0.103
			(0.377)
Observations	4,914	4,914	4,914
Log likelihood	-1310	-1319	-1315
AIC	2680.18	2684.16	2676.85
BIC	2875.17	2833.66	2826.35

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table B2: Random Parameter Logit specifications for lamb

VARIABLES	(1) Model 1	(1) Std. deviations	(2) Model 2	(2) Std. deviations	(3) Model 5	(3) Std. deviations
Interactions with Opt-Out alternative						
Age	0.0620**					
	(0.0305)					
Income	-0.000600					
	(0.000395)					
Male	-2.908***					
	(0.779)					
Education	-0.444					
	(0.438)					
Type of residences (Base level = Urban with significant rural)						
Urban residents	1.592					
	(1.138)					
Rural residents	1.092					
	(1.131)					
Number of children below 18 years	-0.299					
	(0.370)					
Change in expected future income	-0.689					
	(0.913)					
England	-1.885					
	(1.218)					
N. Ireland	-13.62***					
	(3.240)					
Scotland	3.297*					
	(1.867)					
Opt-out	-4.379**	7.174***	-4.957***	6.954***	-4.964***	7.224***
	(2.024)	(1.436)	(0.676)	(0.976)	(0.683)	(1.064)
Price	-0.807***	0.804***	-0.667***	-0.562***	-0.685***	-0.587***
	(0.131)	(0.143)	(0.0848)	(0.0743)	(0.0890)	(0.0799)
Animal Welfare (Base level = Low						
High Welfare = 1	2.340***	2.771***	2.708***	2.526***	0.115	2.562***
	(0.455)	(0.479)	(0.794)	(0.389)	(0.757)	(0.405)
Medium Welfare = 1	1.563***	-1.059*	1.503**	0.809**	0.440	0.843*
	(0.336)	(0.568)	(0.659)	(0.397)	(0.639)	(0.447)
Origin (Base level = Produced outside the UK						
Locally Produced = 1	1.308***	-1.319***	1.195***	0.959***	1.214***	1.055***
	(0.325)	(0.431)	(0.264)	(0.356)	(0.273)	(0.361)
Produced elsewhere in the UK = 1	0.881***	-1.923***	1.078***	-1.068**	1.091***	-1.137***
	(0.326)	(0.511)	(0.289)	(0.439)	(0.297)	(0.428)
Infection level (Base level = 0%)						
10% infection in the flock	-2.050***	0.928*	-1.484**	0.572	-1.856***	0.734
	(0.406)	(0.480)	(0.659)	(0.527)	(0.640)	(0.454)
20% infection in the flock	-2.538***	-1.587***	-1.494*	-1.475***	-2.438***	-1.374***
	(0.516)	(0.450)	(0.834)	(0.416)	(0.718)	(0.428)
30% infection in the flock	-3.438***	-1.276**	-2.787***	1.062**	-2.456***	1.122***
	(0.552)	(0.511)	(0.695)	(0.438)	(0.650)	(0.423)
Interactions with Age						
Age*high welfare			-0.0139			
			(0.0163)			
Age*medium welfare			-0.00323			

		(0.0138)	
Age*10% infection in the flock		-0.00426	
		(0.0136)	
Age*20% infection in the flock		-0.0108	
		(0.0166)	
Age*30% infection in the flock		-0.00124	
		(0.0138)	
Education*10% infection in the flock			0.0434
			(0.241)
Education *20% infection in the flock			0.178
			(0.273)
Education *30% infection in the flock			-0.194
			(0.240)
Age*high welfare			0.825***
			(0.301)
Education*medium welfare			0.403
			(0.248)
Observations	4,248	4,248	4,248
Log likelihood	-1015	-1027	-1023
AIC	2088.52	2100.46	2091.6
BIC	2272.79	2246.61	2237.74

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table B3: Random Parameter Logit specifications for wool

VARIABLES	(1) Model 1	(1) Std. deviations	(2) Model 2	(2) Std. deviations
Interactions with Opt-Out alternative				
Age	0.0685**			
	(0.0320)			
Income	-0.000215			
	(0.000428)			
Male	-2.353***			
	(0.868)			
Education	-0.540			
	(0.428)			
Type of residences (Base level = Urban with significant rural)				
Urban residents	-0.403			
	(1.237)			
Rural residents	-1.768			
	(1.265)			
Number of children below 18 years	-0.628*			
	(0.369)			
Change in expected future income	-1.122			
	(0.803)			
England	0.781			
	(2.028)			
N. Ireland	-4.094			
	(3.007)			
Scotland	0.343			
	(2.260)			
Vegetarian	4.089***			
	(1.378)			
Opt-out	-3.500	6.525***	-3.061***	7.077***
	(3.415)	(0.903)	(0.534)	(0.897)
Price	-0.153***	0.195***	-0.153***	0.179***
	(0.0251)	(0.0368)	(0.0236)	(0.0271)
Animal Welfare (Base level = Low				
High Welfare = 1	2.284***	2.792***	3.886***	2.739***
	(0.331)	(0.408)	(0.782)	(0.350)
Medium Welfare = 1	1.332***	-0.0501	1.619***	-0.401
	(0.230)	(0.373)	(0.579)	(0.390)
Origin (Base level = Produced outside the UK				
Locally Produced = 1	1.448***	-1.362***	1.432***	1.166***
	(0.265)	(0.377)	(0.250)	(0.312)
Produced elsewhere in the UK = 1	1.443***	0.238	1.448***	-0.130
	(0.294)	(0.686)	(0.270)	(0.439)
Infection level (Base level = 0%)				
10% infection in the flock	-1.383***	-0.366	-0.336	-0.648*
	(0.232)	(0.727)	(0.554)	(0.392)
20% infection in the flock	-1.639***	2.356***	0.865	2.085***
	(0.364)	(0.470)	(0.832)	(0.403)
30% infection in the flock	-3.271***	1.816***	-2.169***	1.747***
	(0.404)	(0.365)	(0.698)	(0.351)
Interactions with Age				

Age*high welfare		-0.0386**
		(0.0156)
Age*medium welfare		-0.00718
		(0.0121)
Age*10% infection in the flock		-0.0238**
		(0.0117)
Age*20% infection in the flock		-0.0568***
		(0.0184)
Age*30% infection in the flock		-0.0251*
		(0.0146)
Observations	5,022	5,022
Log likelihood	-1237	-1237
AIC	2533.36	2520.72
BIC	2729.01	2670.72