Valuing animal welfare with choice experiments: An application to Swedish pig production

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VALUING ANIMAL WELFARE WITH CHOICE EXPERIMENTS: AN APPLICATION TO SWEDISH PIG PRODUCTION

Abstract. In this paper, the demand for animal welfare attributes when buying pork fillet is investigated among Swedish respondents. More specifically, the coefficients of an indirect utility function and willingness to pay for animal welfare attributes are estimated. The utility function is estimated using a multinomial logit and a random parameter logit model. A realistic scenario when modelling consumer choices is to allow for heterogeneity in preferences. The random parameter logit model departs from the well known IIA property and allows for a more flexible taste distribution across individuals. The need for assuming randomness of some parameters are evaluated by using a specification testing procedure with artificial variables developed by McFadden and Train (2000). From this study it can be concluded that the preferences for some of the animal welfare attributes are heterogenous across the respondents. There exists both negative and positive wtp for animal welfare attributes. Further, the study reports on the distribution of individual wtp.

Keywords: pig production, consumer valuation, animal welfare, multinomial logit model, random parameter logit model

1. Background and objectives of the study

The pig production sector in OECD countries has during the past decades been experiencing an industrialization process, characterized in part by fewer more efficient and larger production units (Lundeheim and Holmgren, 1994; Rhodes, 1995). Along with a demand for low prices and certain qualities such as for example leanness meat, ethical considerations in livestock production has been raised in the public debate(See for instance Lindgren and Forslund (1990)).

To integrate animal welfare aspects into production is not an unproblematic issue as it is a common view that stricter animal welfare regulation implies additional costs, which in turn will affect the prices on the pork products facing the consumer. (McInerney, 1991; Henson and Traill, 2000; Milne, 2004). Thus, in order for the products to be competitive there has to exist a demand for products with animal welfare attributes. Hoffmann (2000) argues that the Swedish demand for domestic agricultural products may reflect a higher confidence for national production standards. If domestic production have additional qualities in terms of stricter regulations there should exists a positive willingness to pay (here after denoted wtp) for animal welfare attributes. A demand analysis could be useful for the Swedish conventional as well as for the organic pork production sector in order to improve their competitiveness. Given that Sweden is a member of the EU and imports pork from other EU-countries, measures for animal welfare attributes should also be of interest to an international audience. In addition, before a consolidation into a common EU animal welfare regulation the national demand segments should be taken into account.

Commodities with unobservable qualities such as animal welfare attributes are often referred to as "credence goods". The buyer does not have full information about the commodity and the information cannot be evaluated by consumption (Darby and Karni, 1973). The credence character of animal welfare attributes in production implies a complex problem when evaluating animal welfare products. Thus, a sufficient amount of real sales data of products with animal welfare as a quality attribute is not available. Hence, the stated demand for animal welfare attributes are required in order to evaluate animal welfare practices in production.

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Key words and phrases. pig production, consumer valuation, animal welfare, multinomial logit model, random parameter logit model, con-joint analysis, Sweden.

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The main objective of this study is to investigate animal welfare attributes in Swedish pig production. More specifically, wtp (in SEK) for animal welfare attributes is derived. For this purpose, the values of the parameters in the consumers indirect utility function are estimated in multinomial logit and random parameter logit models. The choice experiment data, exclusively collected among Swedish consumers for this study, were obtained with the multiple choice analysis con-joint methodology. As there is reason to believe that the preferences are heterogenous across respondents, a random parameter logit model is used for this purpose. The large sample size used in the choice experiment in this paper allows for conclusions on average consumer behavior. In addition, the relevance of the random parameter specification is tested by mixing the attributes in an ordinary multinomial logit. The welfare attributes analyzed are seven in total and concern transportation, castration, housing system, feed, the mixing of pigs, stock size and availability of straw. The pork product chosen for the study is pork fillet. At the time for the survey the prices on domestic fillet of pork were in average 159 SEK/kg and imported 129 SEK/kg. In 2002, the Swedish pork market was constituted by 80 percent domestic production. Imported pork was mainly from Denmark (Statistics of Sweden). The average price for organic pork products on the market was in average 25 percent higher than the price of the conventional product.

Previous surveys dealing with hypothetical markets mostly use the contingent valuation method (CVM). Drake and Holm (1989) investigated the wtp for unconventionally produced meat products in a free market situation. Bennett and Larson (1996) conduct a CVM study of wtp for a ban against cages in egg production and restricted diets and crates in veal production. Bennett (1997) measures the wtp for a ban of battery cages in egg production in the European Union. Anderson and Frykblom (1999) use two parallel CVM studies in order to study free range versus battery cage production. Rolfe (1999)investigates and values animal welfare concerns by stated preference and wtp in free-range egg production. However, the CVM approach does not give any relative measures on the attributes. Due to the complexity of agricultural production it can be useful to adopt a multiple choice approach in valuation. den Ouden (1996) uses a conjoint analysis in order to evaluate pig welfare perceptions among a small sample of consumers and pig welfare experts. The investigation includes 12 attributes concerning the farrowing, fattening, slaughtering and transportation stages of production. A common assumption when performing valuation studies in animal welfare matters is to assume that preferences are heterogenous across the respondents. Several authors have adopted models that allow for the heterogeneity assumption. Larue et al. (2004) use a random parameter logit model in order to analyze the stated choices from 1000 Canadian respondents regarding genetically modified food, functional food and organically produced food. Enneking (2004) investigates the wtp for quality assurance schemes that has been introduced in German meat sector by the use of a random parameter logit model.

A well-known problem with stated choice surveys is the hypothetical bias. Respondents tend to overstate their wtp when asked hypothetical questions.(Cummings et al., 1995; Frykblom, 1997; Johannesson, 1997) Some authors have addressed this problem by calibrating factors. The size of commodity-specific calibration factors has been estimated by Alfnes (2003); Fox et al. (1998); List and Shogren (1998). The biased stated-choice data have been calibrated by using information from experimental auctions. The size of the factor is assumed to be commodity specific (List and Shogren, 1998). The literature suggests a wide range of calibration factors for meat products. List and Shogren (1998) proposed a factor of 0.6 in an irradiated/radiated meat survey. Alfnes (2003) reports a calibration factor of 0.1 in a hypothetical survey of hormone treated US-beef. Lusk (2003) investigates how "cheap talk" affects the stated wtp for genetically modified food. Carlsson et al. (2004a) uses a "cheap talk" script in order to diminish the problem with the hypothetical bias in choice experiment study of mobile abattoirs. The wtp estimates in this survey are realistic, but previous studies suggested that a hypothetical bias has to be acknowledged. The size of any such bias is not assessed in this paper. Further, the model is limited in the sense that it does not include underlying attitudes and perceptions in the modelling framework. Ethical concerns in animal welfare and livestock production may be constituted by factors such as food safety as well as animal welfare concerns. Estimations of choice models where such factors are ignored may produce inconsistent estimators.

The paper is organized as follows. Next, the Random Utility Maximization (RUM) theory is presented in order to explain individual utility and choice behavior. The econometric models multinomial logit and random parameter are derived from the indirect utility function. The delta method that underlies the derivation of willingness to pay in the multinomial logit model is presented. Moreover, the relevant animal welfare concerns in pig production and the welfare attributes investigated in this study are discussed. Finally, the econometric results are reported and a discussion concludes the paper.

2. **Econometric model specification**

Choice behavior by a decision maker are mostly modelled within the Random Utility Maximization (RUM) framework developed by Marschak (1960). The behavioral model is that the individual choose alternative i with probability P_{ni} *iff* $P(U_{ni}) > P(U_{nj})$ for all $j \neq i$. This can also be decomposed into deterministic and stochastic parts. After some rearrangements we have the relation $P(\varepsilon_{nj} - \varepsilon_{ni}) < P(V_{ni} - V_{nj})$. Discrete choice models are derived from the distributional assumptions of the error terms. This implies that the coefficients of the attribute in utility function are expressed in relative values, i.e. the value of the attribute compared by the attribute's base scenario.

The coefficients of a hypothetical average indirect utility function from animal welfare attributes are estimated in this paper. The indirect utility function is assumed to be linear in the parameters (McFadden, 1974). Utility is assumed to decrease with increasing level of the price attribute and either increase or decrease with animal welfare attributes. For an individual n facing a choice j, the indirect utility is assumed to take following form:

$$U_{nj} = \alpha_{nj} + \boldsymbol{\gamma'_j s_n} + \boldsymbol{\beta'_n x_{nj}} + \varepsilon_{nj} \tag{2.1}$$

The achieved utility may vary between choice (where the total number of choices are $J = 1, ..., j$) and individuals n (the total number of individuals are $N = 1, ..., n$). Here, the indirect utility for a choice within J is assumed to consist of a deterministic part $V_{nj} = \alpha_{nj} + \boldsymbol{\gamma'_j s_n} + \boldsymbol{\beta'_n x_{nj}}$ and a stochastic part ε_{nj}(Train, 1998). The former component of the utility function consists of the parameter α_{nj} which is the intercept or individual n's intrinsic preference for choice j. The parameter vector $\boldsymbol{s_n}$ contains the descriptive statistics of the individual and the coefficient vector $\boldsymbol{\gamma_j}$ captures the systematic preference heterogeneity among the individuals in the sample. There are in total seven welfare components and one price components to be investigated. Each welfare component to be valuated has two or three sub-levels-the attributes- where one constitute the base scenario. In total there are 13 attributes to be estimated. Each choice j facing individual n is a combination of seven different welfare attributes and a corresponding price attribute. Thus the choice is a vector $\boldsymbol{x_{nj}} = [x_{nj1}, ..., x_{nj8}]$, where x_{nj1} is the price attribute and $[x_{nj2}, ..., x_{nj8}]$ are the welfare attributes. The total attribute vector $\boldsymbol{\beta_n}$ contains 13 coefficients to be estimated; $\boldsymbol{\beta_n} = [\beta_{n1}, ..., \beta_{n13}]'$. The coefficient vector of the attributes and is assumed to be generic, i.e. it does not vary between the choices. The individual error term ε_{nj}, is assumed to be random.

2.1. **Model 1: the multinomial logit model.** The cumulative distribution of the error term in the multinomial logit model is assumed to be iid Gumbel $F(\varepsilon_n) = e^{-e^{-\varepsilon_n}}$ (Train, 2003). Evaluating the probability for individual n choosing alternative i; we have $P_{ni} = P(\varepsilon_{nj} < \varepsilon_{ni} + V_{ni} - V_{nj}$. The cumulative distribution and the assumption of independent error terms implies that we can write the multinomial logit choice probability as:

$$\mathrm{P_{ni}} = \frac{e^{\alpha_{ni} + \boldsymbol{\gamma'_i s_n} + \boldsymbol{\beta'_n x_{ni}}}}{\sum_j e^{\alpha_{nj} + \boldsymbol{\gamma'_j s_n} + \boldsymbol{\beta'_n x_{nj}}}}$$

The conditional multinomial logit probability takes a closed form between 0 and 1. The unconditional multinomial logit probability is derived by summing over all respondents and choices, where a dummy variable y_{nj} takes value 1 for the chosen alternative and 0 for the non-chosen alternatives. We have the log-likelihood as:

$$LL(\alpha_{nj}, \boldsymbol{\beta_n}, \boldsymbol{\gamma_j}) = \sum_{n=1}^{N} \sum_{j=1}^{J} y_{nj} \ln P_{nj}$$

From the first order condition of the log-likelihood function, we are able to estimate the coefficients in $\boldsymbol{\beta_n}$, $\boldsymbol{\gamma_j}$ and α_{nj} on individual level and sample level.

The core of the multinomial logit model is that the unknown utility terms ε_n are assumed to exhibit independence from irrelevant alternatives (IIA)(Louviere et al., 2000). The IIA assumption implies that the values of the coefficients and their standard errors of the indirect utility are assumed to be fixed across the sample. Thus the $\boldsymbol{\beta_n}$ can be simply defined as $\boldsymbol{\beta}$. The IIA assumption necessary for the multinomial logit model formulation can be somewhat strong. In order to test whether the IIA assumption in the multinomial logit model should be relaxed, McFadden and Train (2000) have developed a testing procedure that investigates the need for mixing parameters, i.e. for if and which parameters exhibit randomness. As heterogeneity requires simulation in order to be modelled, the testing make use of the estimated P_{nj} of multinomial logit model. The artificial variables are created from the non-chosen alternatives. Thus the vector $[z_{n(j-1)2}, ..., z_{n(j-1)8}]$ are linearly independent from the attribute vector $[x_{nj2}, ..., x_{nj8}]$. The artificial variables from each attribute component $\boldsymbol{x_{nj}}$ are constructed as:

$$\boldsymbol{x_{n(j-1)}} = \sum_{j-1} \boldsymbol{x_{n(j-1)}} \cdot P_{n(j-1)} \tag{2.2}$$

and

$$\boldsymbol{z_{nj}} = 1/2(\boldsymbol{x_{nj}} - \boldsymbol{x_{n(j-1)}})^2 \tag{2.3}$$

By definition, For a more extensive derivation of the testing procedure, see McFadden and Train (2000). A likelihood ratio test can be performed in order to test for the hypothesis that the artificial variables should be omitted from the multinomial logit model.

2.2. **Model 2: The random parameter logit model.** In the random parameter logit model the coefficient vector $\boldsymbol{\beta_n} = [\beta_{n1}, ..., \beta_{n13}]'$ is assumed to be constant across the choices of an individual and follow a distribution across the population. Thus we allow for heterogenous preferences. The amount the individual $\boldsymbol{\beta_n}$ differs form the population mean $\boldsymbol{\beta}$ constitutes the unobserved taste variation in the sample. We do not observe enough of replications in order to have estimates of $\boldsymbol{\beta_n}'$. Instead we use its expected value across the population and assume that each coefficient β_{nk} $(k = 1, ..., 13)$ is independent and normally distributed with parameters (β_k, σ_k^2). (Ben-Akiva and Lerman, 1985) As the $\boldsymbol{\beta_n}$ are assumed to have normal distributions for the sample the coefficients are allowed to have different signs for different respondents (Carlsson et al., 2003). In addition, due to the random specification of the coefficient vector, positive or negative correlations between the parameters may exist.

The expected value of choice probability of individual n to choose alternative i is a weighted average of the logit probability evaluated at different values of $\boldsymbol{\beta_n}$. The density function $\boldsymbol{f(\beta_n)}$ is the mixing distribution. We have the choice probability as:

(2.4)
$$E(P_{ni}) = \int_{\beta_{n1}} \cdots \int_{\beta_{nk}} \frac{e^{\alpha_{ni} + \boldsymbol{\gamma_i' s_n} + \boldsymbol{\beta_n' x_{ni}}}}{\sum_{j \in C_n} e^{\alpha_{nj} + \boldsymbol{\gamma_j' s_n} + \boldsymbol{\beta_n' x_{nj}}}} f(\beta_{nk}) \cdots f(\beta_{n1}) d\beta_{nk} \cdots d\beta_{n1} = \int_{\boldsymbol{\beta_n}} P_{ni} \boldsymbol{f(\beta_n)} d\boldsymbol{\beta_n}$$

which has to be simulated. The average constitute the the simulated log-likelihood (SLL). The first order conditions can be derived in a similar manner as for the multinomial model (Train, 2003).

Train (2000) suggests that the fit of random parameter logit models is improved with fewer and more even draws from the distribution, so called Halton draws. This is adopted in this setting. Further, Train also suggests that several hundreds of replications should be performed in order to have an unbiased estimator.

3. The willingness to pay for attributes

The wtp for individual n is most commonly defined as the net income change that is equivalent to a change in quality or quantity of a good (Just et al., 1982; Freeman, 1993). A choice $\boldsymbol{x_{ni}}$ is preferred to $\boldsymbol{x_{nj}}$ if the condition $U(\boldsymbol{x_{ni}}) > U(\boldsymbol{x_{nj}})$ is fulfilled and changes in $\boldsymbol{x_{nj}}$ are thought to be desirable for the individual ($dU/d\boldsymbol{x_{nj}} > 0$) (Haab and McConnell, 2002).

$$U(\alpha_{ni}, \boldsymbol{s_n}, \boldsymbol{x_{ni}}) - WTP = U(\alpha_{nj}, \boldsymbol{s_n}, \boldsymbol{x_{nj}}) \tag{3.1}$$

Due to the definition of discrete choice models, the estimated attribute coefficients can be interpreted as the marginal increase or decrease of utility. This makes the interpretation of the wtp from the utility function straight forward; the marginal change in price from a marginal change in attribute level. Calculating the average and individual wtp involves the computing products of estimated parameters. Thus the mean and variance of the product is approximated by using delta method with a first order Taylor expansion around the estimated coefficients (Greene, 2000).

It is also possible to use estimated coefficients on individual level in order to have the individual mean wtp. For this purpose we use Bayes theorem. Thus a distribution of wtp based on individual data can be retrieved. Train (2003) shows that the mean wtp at individual level can be derived as:

$$E[\boldsymbol{\beta_n}] = \frac{\int_{\boldsymbol{\beta_n}} \boldsymbol{\beta_n} P_{ni} \boldsymbol{f}(\boldsymbol{\beta_n}) d\boldsymbol{\beta_n}}{\int_{\boldsymbol{\beta_n}} P_{ni} \boldsymbol{f} \boldsymbol{d\beta_n}} \tag{3.2}$$

As the individual error term , ε_{nj}, is assumed to have normal distribution, the estimated coefficients may take negative values. Hence the wtp may be negative if the respondent dislike the attribute very much. According to the definition, this is the wtp for attribute 2. An important notion is that the attributes are not perfect substitutes. Hence the marginal effects are not additive; it is not possible to summarize the wtp for each attribute and get an aggregate measure on wtp.

4. **Assessing and measuring animal welfare in pig production**

There is an extensive literature on how to assess the level of animal welfare.[1] Although there is no single definition of animal welfare, there are certain agreements of principles that can be applied to the entire livestock sector. The indicators commonly used are health (frequencies of illness, fitness), productivity (growth rate, ability to digest feed), physiology (visible injuries, heart rate, stress response) and ethology (behavior in a specific surrounding). Each of these indicators has a potential to provide a measure of the animal's well being. The problem is, according to Mason and Mendl (1993), that these measures are not easy to interpret and do not always co-vary. As a solution to this problem many authors suggest an integrated approach of the indicators when defining animal welfare.[2]

In accordance with this literature, eight welfare attributes in pig production are defined [3]. Further, in order to investigate consumers demand for specific animal welfare attributes, some additional research have been performed in focus-group discussions with consumers on two occasions [4], interviews with representatives from consumer associations, The Federation of Swedish Farmers (LRF), Swedish Meats and the Swedish University of Agricultural Sciences. Finally, the specific regulations applied by the farms connected to the organic production (KRAV) are considered in attribute formulation. The welfare attributes (cf.table 1) concern transportation, housing systems, stock density, supply of straw, castration, mixing unfamiliar pigs, and feed.

The data was collected with the con joint choice modelling technology (Louviere et al., 2000). In this setting each of the attributes has two or three quantified sub-levels. This implies that there

[1](Fraser and Broom, 1990; Broom, 1991; Keeling, 1996; Smidt, 1983; Mason and Mendl, 1993; Hurnik, 1988; McGlone, 2001)

[2](Fraser and Broom, 1990; Broom, 1988, 1991; Keeling, 1996; Smidt, 1983; Sandoe and Simonsen, 1992; Mason and Mendl, 1993)

[3]Due to space limitation, the literature review is not included in the paper but can be provided from the author upon request

[4]Due to space limitation, the results from the focus group discussion are not included in the paper but can be provided from the author upon request

Table 1. Welfare attributes in the Swedish pig production

Attribute	Level
Transport	1. Transports according to existing regulations and limited by time 2. Mobile slaughter system 3. Transports according to existing regulations and limited by distance
Castration	1. Castration of piglet without anaesthesia 2. Castration of piglet with anaesthesia 3. No castration of piglets
Housing system	1. Reared in a pen with 8 pigs (size=$0.90m^2$/100 kg pig) 2. Reared in deep litter with 50 pigs (size=$1.3m^2$/100 kg pig) 3. Reared in a pen with 8 pigs with a possibility to remain inside and outside (size=$2m^2$/100 kg pig). During summertime pasture with an opportunity for mud bathing and grazing is provided
Feed	1. No restrictions on feed or minimum limit of home produced feed 2. No minimum level of home produced feed but all feed has to be Swedish 3. All feed has to be Swedish, produced without pesticides and commercial fertilizers and at least 50 percent of it has to be produced on the own farm
Mixing pigs	1. Mixing of unfamiliar pigs allowed 2. No mixing of unfamiliar pigs allowed
Stock	1. A maximum of 400 pigs in one section 2. A maximum of 200 pigs in one section 3. A maximum of 100 pigs in one section
Straw	1. No minimum restriction of straw in pens 2. Minimum level of straw in pens

are 972 possible combinations [5] of animal welfare attributes (or utility levels). With the OPTEX procedure in SAS, a linear D-optimal design procedure, (Kuhfeld, 2001), 32 orthogonal combinations were created to be used in the survey. These were blocked into 4 different survey versions, each containing four choice sets. Each choice set included three combinations (i.e.alternatives). Additional to the animal welfare attributes, a price attribute vector was included.

The first alternative always referred to a base scenario, no additional price was attached to the alternative. Alternative 2 and 3 included an increase of the price due to higher level of animal welfare. The vector of bids on pork fillet was determined to be $4, 10, 16, 21, 27, 33$ and 40 SEK/kg. The corresponding price for an attribute vector was set in order to be realistic and perceptible for the respondent with respect to budget constraints.

A sample of Swedish respondents at ages between 18 and 75 were obtained from SPAR [6]. A total of 3000 individuals in Sweden received the questionnaire in May 2002. After two weeks a letter of reminder was sent to each of the respondents. After an additional two weeks a copy of the questionnaire was sent to those respondents who had still not answered. In total, 1400 (45 percent) of the questionnaires were returned and of these 1250 (43 percent) were available for an empirical analysis. It was not a requirement that all four choice-sets had to be completed in order for the questionnaire to be included in the survey. The questionnaire consisted of two parts. In

[5] This is equated as $(3^5 * 2^2)$

[6] Statens Person och Adress Register

addition to multiple choice questions, the respondents provided some socio-economic information like income, education and age. With each questionnaire accompanied an information sheet regarding the different stages of the Swedish pig production chain, in which the attributes were presented and illustrated.

5. Econometric results

In Table 2 some descriptive statistics of the respondents are presented. Where national

Table 2. Descriptive statistics of the respondents

Variables	Description	Mean	se	Min	Max
Age	Average age of the respondent	46.10	15.23	18	75
Male	Proportion men in the sample	0.4463	0.4971	0	1
Kid	Proportion households with children	0.3434	0.4749	0	1
Dummy	Proportion questions addressing pork chops or pork fillet	0.1014	0.3018	0	1
Prhh	Average number of persons in the household	2.612	1.282	1	8
Inc	Average household income/month after tax	20874	9676	9999	45000
Rel	Proportion of persons who consider themselves to have relation to the agricultural sector	0.5203	0.4996	0	1
Sass	Proportion of members of a "socially oriented" association	0.1308	0.3372	0	1
Eass	Proportion of members of an "environmentally oriented" association	0.1252	0.3310	0	1
Shop	Proportion of respondents doing household shopping	0.8386	0.3679	0	1
NonVeg	Proportion of non-vegetarians in the sample	0.9834	0.1278	0	1
Samh	Proportion living in a village (1000-9999 inhabitants)	0.1841	0.3875	0	1
Minc	Proportion living in a minor city (10 000-39 999 inhabitants)	0.1595	0.3661	0	1
Medc	Proportion living in a medium sized city (> 40000 inhabitants)	0.2094	0.4069	0	1
Stad	Proportion living in a big city (Stockholm, Gothenburg or Malmö)	0.2707	0.4443	0	1

statistics were available, comparisons with the descriptive statistics of the sample was performed; the mean value of age was slightly higher in the sample, women displayed a higher response-rate, the average proportion of children/respondent and the average number of persons in the household was higher in the sample.In order to achieve as good fit as possible, i.e. a contribution of the descriptive attributes in utility function, some of the socio- economic variables were eliminated. In the final estimation of the multinomial logit and random parameter logit model, the descriptive variables Sex, Income and NonVeg were included. These were assumed to interact with the alternative specific intercept, α_{ni}, and included in the two non-base alternatives since presentation was in generic form (Carlsson et al., 2003).

TABLE 3. Estimated fixed coefficients of utility function with multinomial logit model (mnl)and with the specification test. The artificial variables in the specification test with an absolute T-value larger than one is denoted with a*

	MULTINOMIAL LOGIT MODEL		SPECIFICATION TEST	
Variable	Coefficient	SE	Coefficient	SE
Transport by distance,β_2	0.1549	0.0811	0.2613	0.6372
Mobile slaughter, β_3	0.3346	0.0666	-0.0029	0.4018
No castration, β_4	-0.1531	0.0741	-0.8314	0.5942
Castration anaesthesia, β_5	0.3801	0.0655	-0.7719	0.6635
Big box, β_6	0.0601	0.0796	-1.0724	0.6477
In-out box, β_7	0.5187	0.0646	-0.1966	0.4748
Swedish feed, β_8	0.3591	0.0748	1.1688	0.4607
Farm feed,β_9	0.4289	0.0648	0.2386	0.3422
Stock limit:200pigs, β_{10}	0.3066	0.0746	0.0885	0.4697
Stock limit:100pigs, β_{11}	0.2736	0.0956	0.3463	0.3477
No mixing of pigs, β_{12}	0.2451	0.0540	-1.0797	0.3917
Minimum level of straw, β_{13}	0.1230	0.0600	0.3138	0.3446
Intercept, α	-0.0600	0.2990	0.1148	0.3158
Price, β_1	-0.0110	-0.0470	-0.0111	0.0066
Sex	0.2906	0.0747	0.4234	0.0803
Inc	-0.0187	0.0091	-0.0274	0.0093
Veg	0.5490	0.2792	0.8279	0.2849
Artificial variables				
Transport by distance,β_2			-0.4567	1.7179
Mobile slaughter, β_3			1.2768*	1.1303
No castration, β_4			1.3937	1.6724
Castration anaesthesia, β_5			3.7111*	1.9301
Big box, β_6			3.1042*	1.7104
In-out box, β_7			1.5815*	1.3795
Swedish feed, β_8			-1.3538*	1.1381
Farm feed,β_9			1.2567*	0.9861
Stock limit:200pigs, β_{10}			0.8362	1.3215
Stock limit:100pigs, β_{11}			0.2573	1.0036
No mixing of pigs, β_{12}			4.1542*	1.1796
Minimum level of straw, β_{13}			-0.2142	0.9525
Log-likelihood	-3933		-3906	
Pseudo-R^2	0.1412		0.1472	

The results provided with the multinomial logit and the specification test with artificial variables are presented in table 3.

5.1. **Multinomial logit model (mnl).** Assuming that the preferences across the respondents in the pork fillet sample are identical, the coefficient of the attribute 'Big box'is not significant. The intercept is non significant. The significant estimates of the descriptive variables 'Sex','Inc' and 'NonVeg' indicates that respondents that are non vegetarians tend to be more likely to choose an improved animal welfare. The negative sign in front of the parameter 'Inc' indicate that respondents with high income are less likely to choose an improved animal welfare. Men have a larger probability to choose increased welfare. The price coefficient is negative, thus higher price provides a negative utility for the respondent.

5.2. **Specification test.** Randomness/taste variation among the respondents can be indicated when estimating model 1 with the artificial variables suggested by McFadden and Train (2000).

McFadden and Train (2000) use the T-statistics to test the hypothesis of the coefficient vector different from zero. The T-statistic does not have to be a reliable guide for the location of mixing though, due to lack of independence and correlation between attributes. The decision rule applied in order to have randomness, is that the absolute T-value should be larger than one for the estimated coefficient. The artificial variables for 'Mobile slaughter','Castration with anaesthesia','Big box','In-out box','Swedish feed','Farm feed' and 'No mixing of pigs' have an absolute T-value larger than one.

5.3. **Random parameter logit model (rpl).** The model was simulated with 300 replications, maximum 100 iterations and Halton draws. The results achieved from the specification test above gives a good indication which of the variables that could be assumed to be random. A simulation with the suggested variables as random yielded a non significant value of the price parameter. In order to get a model fit with significant price parameter the variable 'In-out box' was assumed to be fixed. This variable has a T-value close to unity in the specification test, which may cause a problem in the random model specification. The variable 'Big box' is highly insignificant as in the multinomial logit model and 'Swedish feed' is not significant on the 10 percent level.

TABLE 4. Random parameter logit model

Variable	Coefficient	SE
Fixed effects		
Transport by distance,β_2	0.3663	0.2351
No castration,β_4	-0.4800	0.2542
In-out box,β_7	0.9972	0.2700
Stock limit:200 pigs,β_{10}	0.3817	0.2432
Stock limit:100 pigs,β_{11}	0.2823	0.3928
Minimum level of straw,β_{13}	0.3775	0.2087
Intercept,α	-0.1679	0.7380
Price,β_1	-0.0287	0.0131
Sex	0.7125	0.2067
Inc	-0.0399	0.0199
Veg	1.4221	0.7214
Random effects		
Mobile slaughter,β_3	0.5967	0.3016
Castration anaesthesia,β_5	0.7779	0.2735
Big box,β_6	-0.3309	0.4077
Swedish feed,β_8	0.5740	0.3643
Farm feed,β_9	1.0099	0.4010
No mixing of pigs,β_{12}	0.8129	0.2899
Log-likelihood function	-3896	
Pseudo-R^2	0.1496	

In order to make the estimated value of the parameters from the random parameter logit model more comprehensive, the average wtp with a standard error is derived for each of the variable. The average wtp from the multinomial logit model and the random parameter logit model are presented in Table 5 below.

The distribution of individual wtp is presented in Appendix 1.

TABLE 5. The mean wtp in SEK from the mnl and rpl model estimates.

	MNL		RPL	
Variable	wtp	SE	wtp	SE
Transport by distance,β_2	14.59	2.128		
Mobile slaughter,β_3	32.40	11.79	20.80	9.532
No castration,β_4	-13.68	8.586		
Castration anaesthesia,β_5	38.85	17.21	27.07	16.16
Big box,β_6				
In-out box,β_7	49.69	18.60		
Swedish feed,β_8	35.40	15.97	19.98	14.23
Farm feed,β_9	39.82	16.06	35.15	19.10
Stock limit:200 pigs,β_{10}	29.41	13.13		
Stock limit:100 pigs,β_{11}	23.01	10.08		
No mixing of pigs,β_{12}	23.86	10.77	28.29	16.60
Minimum level of straw,β_{13}	9.594	5.689		

6. **Concluding remarks**

Estimating consumer utility function for animal welfare attributes in Swedish pig production, some important results have been found. Firstly, most of the attributes are achieved as welfare improving among the respondents. In the multinomial logit model the attributes 'In-out box', 'Farm feed', 'Castration with anaesthesia', 'Swedish feed' and 'Mobile slaughter' have a wtp more than 30 SEK. In the random parameter logit model the attributes 'Mobile slaughter', 'Castration with anaesthesia', 'Swedish feed', 'Farm feed' and 'No mixing' are treated as random and have a positive mean wtp. The non randomness of some parameter values can be explained by that the distributions degenerate, i.e. the standard deviation approach zero as the sample size increases. Secondly, we can conclude that preferences for animal welfare attributes are heterogenous among the respondents. The log-likelihoods and the Pseudo-R^2 differ between the multinomial logit model, the testing with artificial variables and random parameter logit model. A likelihood ratio test statistics was computed in order to test if the multinomial logit model is affected by introducing artificial variables. The test indicates that the multinomial logit is affected by the parametrization and model fit is improved by mixing the parameters. In addition, a likelihood ratio test indicates that the random parameter logit model provides better information of the utility function than the multinomial logit model. As there is diversity in respondents wtp for welfare attributes, mean values as well as the distribution of individual wtp is presented for the random variables. Moreover, vegetarians in the sample was less likely to choose an improved welfare could be explained by that vegetarians did not always provide answers in the multiple choice part of the questionnaire. Moreover, because of the relatively small size of the sub-sample of vegetarians, it is not possible to estimate representative parameters of the utility function for this group. Men tend to choose an improved animal welfare. However, women tend to do most of the household shopping according to the survey. The fact that higher income implies a lower wtp is a surprising result. The results from Carlsson et al. (2004b) indicate that income does not affect wtp. Thus,in this setting socio economic factors such as income, gender and eating habits may have a limited contribution to the modelling of preferences.

The main contribution with this paper is the existence of a positive valuation for animal welfare, finding of heterogeneity of preferences, the relative magnitude between the values of the parameters and the utility function for animal welfare. Besides development of human utility function for animal welfare, this study suggests a number topics for further studies on economic issues relating to animal welfare.

Interpreting the wtp from this study should be done in a cautionary manner. According to Hanemann and Kanninen (1998) inconsistences in stated choice models may be explained by heterogenous preferences. The random parameter logit model is created in order to be more consistent with statistical models of human behavior. Some heterogeneities of this sample are captured within this framework, but one may suspect that the values of wtp can be overstated and contribute further to a hypothetical bias.In order to make the study more compatible with reality one should address the hypothetical bias in an accurate manner. One possible way to proceed would be to further assess the level of hypothetical bias by auction bids and correct inflated levels of wtp in a similar way as Alfnes and Rickertsen (2003); Fox et al. (1998); List and Shogren (1998).

The wtp at the real market may be affected by information asymmetries due to labelling of products. The question is if the consumer pays for; and receives the demanded products. The credence character implies that existing regulations like third party monitoring and repeated purchase is important. Further market segmentation may be possible; products with higher animal welfare standards to a slightly higher cost than that of conventional products may be demanded.

A notable issue is the relatively diverse support among the respondents for the attribute 'In-out box'. This attribute is in organic production today. The small share of organically labelled pork products at the market(The KRAV-labelled meat constitute only c. 1 percent of the meat market in Sweden) may also be explained by information asymmetries. KRAV is by many consumers regarded as a production that follows stricter environmental regulations. Here the problem is that the KRAV-label is not a pure "animal welfare" labelling. The KRAV-label includes additional environmental regulations that presumably is affecting the price. Therefore, one may not unambiguously conclude that the small market share of KRAV-labelled products implies a weak demand for animal welfare products.

Finally, in order to investigate how stricter animal welfare practices has influenced Swedish production, one may investigate the effects from improved animal welfare within an modelling framework. Here the impacts on Swedish pig producers of stricter legislation can be evaluated.

Figure 1. Distribution of individual wtp for 'Mobile slaughter'

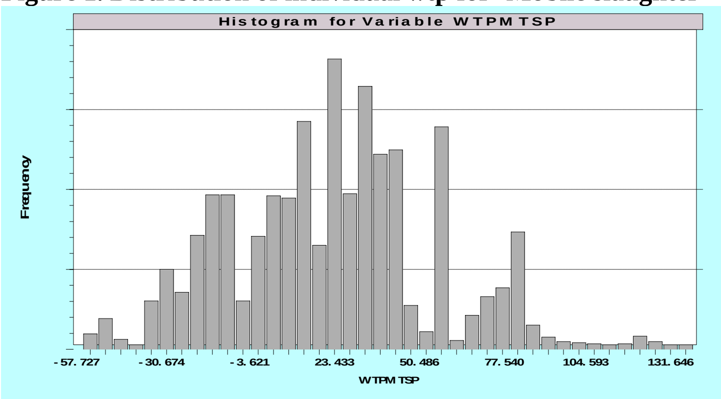


Figure 2. Distribution of individual wtp for 'Castration with anaesthesia'

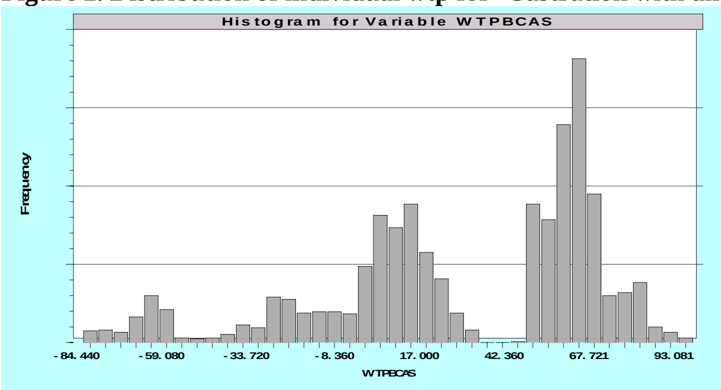


Figure 3. Distribution of individual wtp for 'No mixing'

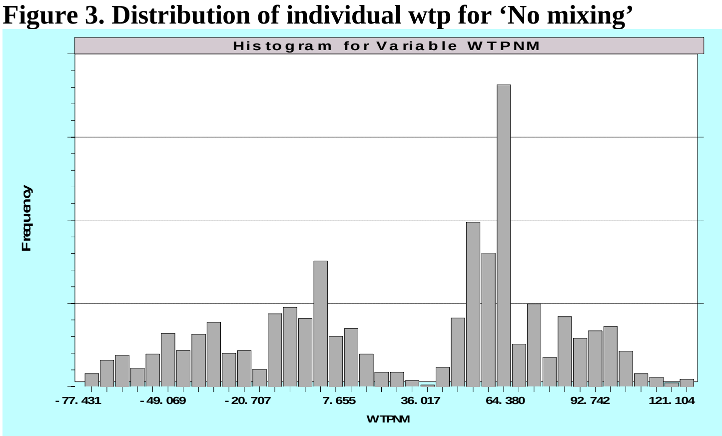
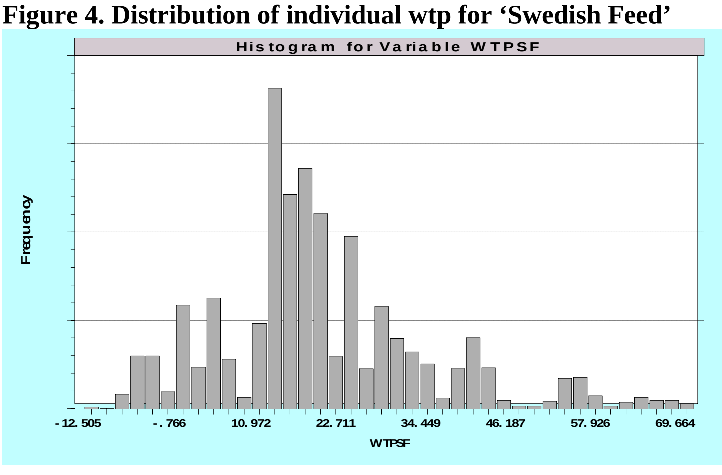


Figure 4. Distribution of individual wtp for 'Swedish Feed'



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