Farm Animal Welfare
- testing for market failure

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Abstract

Our increasingly heterogeneous food is at least partly due to concerns over conventional production of farm livestock. Some of these new products have been demand driven while others are a result of politically decided restrictions on production techniques. From a policy perspective, the interesting question is whether there exists a market failure. We suggest a survey design that enables the researcher to measure the eventual external market failures in farm livestock production. Applying this survey design to the question of battery cages in egg production, we cannot show that there exists a market failure. The policy implications are applicable to not only the question of egg production, they can be extended to a general discussion of how potential market failures for all kind of farm livestock should be managed. Logically, if an external effect cannot be shown, the consumer is better off herself making the choice of how her food is produced.

Keywords: Animal welfare; choice experiments; market failure.

JEL-classification: D62, Q13, Q18.

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Introduction

The multiple roles of agriculture receive increased attention worldwide. It is generally recognized that agriculture is more than just its primary purpose; production of food, fiber and other commodities. Considerable attention is now given to the production of positive and negative external effects. The economic impact of agricultural externalities have been estimated in a number of articles, examples include the pastoral landscape, historical values and nitrogen run-off, see Boyle *et al*. (1999), Brunstad, Gaasland and Vardal (1999) and Prückner (1995). It has been suggested that also farm animal husbandry may be a source of external effects, McInerney (1993). While the welfare of farm animals has been a topic of public concern for a relatively long time in Europe, a number of recent events indicate an increasing interest also in the US. Prime examples include voters in Florida passing an amendment that prohibits the confinement of pregnant sows in small cages, agreements by fast-food chains to stop buying chicken treated with fluoroquinolone antibiotics and the enacted legislation in New Jersey calling for humane treatment and sale of domestic livestock.

While a policy maker can chose from a whole battery of instruments in order to correct for the possible negative external effect of animal welfare, the typical response within the European Union has been the use of regulations, Bennett (1997). Production regulations can increase the provision of desirable product attributes, however, the regulations may also raise production costs. If higher costs are not matched by at least the same magnitude of benefits, the regulation will be detrimental to the welfare of consumers. Furthermore, once regulations are implemented, they are many times difficult to revert due to large economic and political costs. It is important, therefore, to show that there exists a negative external effect before any action is undertaken.

Empirical tests of the presence and extent of negative external effects of farm animal husbandry have been conducted in numerous countries, including Australia, Finland, Northern Ireland, Sweden, United Kingdom and USA. Almost all of these studies have been applied to eggs produced by hens kept in battery cage versus free range production systems; see Bennett and Larson (1996), Andersson and Frykblom (1999), Bennett (1997) and Rolfe (1999). A significantly higher willingness-to-pay (WTP) has consistently been found for the presumably more animal friendly free range system, a fact that has been interpreted as an indication of external effects in battery cage systems.

Our general concern in this study is the design of previous studies. Utilizing existing theory, we show that the nature of possible external effects in farm animal husbandry necessitates a design that isolates the external effect. While previous surveys may not have been designed to accurately measure externalities, we demonstrate how choice experiments can be used to achieve this. A large-scale choice experiment is applied to the question of eggs from battery cage and free range production systems. Using a design that addresses our concerns, we cannot show that a ban of cages in egg production would increase social welfare. As the results contradict the previous literature, this supports our hypothesis that previous surveys might have overestimated the benefits of a ban in the use of cages. Consequently, the consumers are in this specific case better off with a market solution where they are allowed to choose how their eggs are produced.

Theoretical background

Improved conditions for farm animals can be beneficial not only to the animals, but also to consumers and producers. For example, improved functioning of the animal's immune system benefits the producer, reduced stress level and use of antibiotics affects the consumer's perceived quality of meat. Besides perceived changes in food quality, a consumer's utility might also be affected by perceived changes in animal welfare (AW). A number of authors have suggested that modern intensive farm animal production can create negative external effects due to poor AW, see McInerney (1993), Bennett (1995), and Bennett and Larson (1996).

A detailed and rigorous discussion of different possible definitions of AW can be found in a report prepared by Bennett *et al*. (2000) for the British Ministry of Agriculture, Fisheries and Food. The authors conclude that the choice of definition depends on scientific background and ethical choices. Previous economic valuation studies have, explicitly or implicitly, relied on a definition by McInerney (1993) where the welfare of animals only is accounted for when human welfare is affected by animal welfare. This is also the typical assumption made in welfare economics. We rely on this human centered definition in the remainder of the paper. However, it is important to be aware of that this ethical perspective clearly has implications for our conclusions.

Following McInerney (1993) and Bennett (1995), effects on a consumer's utility due to changes in AW can be separated into two parts. The first part, private animal welfare cost (PAWC) is the disutility that a consumer may associate with the conditions under which her own consumed food was produced. The second part, social animal welfare cost (SAWC) is the disutility the consumer may experience due to others' consumption. Even if you do not consume the animal product yourself, the mere knowledge that others do, and thereby support an existing standard of AW that you disagree with, may create disutility. The PAWC is a result of own consumption and as such it can be internalized by the consumer. All an internalization requires is an opportunity to choose between similar food commodities produced under different conditions or opt-out, that is, not buy it at all. As SAWC is unaffected by own consumption, it can be seen as an external effect.

Suppose now that we want to investigate whether there exists a significant negative externality in battery cage egg production. A comparison of the WTP for eggs from battery cage and free range systems is not enough, as more than the SAWC will differ. A difference in the WTP could be due to a number of factors, such as perceived taste, food safety and other quality aspects, Rolfe (1999). For the same reason, is it not sufficient to find a significant price premium for a scenario where battery cages are banned and only free range systems are allowed. This is, however, the comparison that has been used in previous empirical studies. Even if we are willing to assume that the higher WTP is entirely due to improved animal welfare, this would most likely be a combination of a WTP for a reduction of PAWC and SAWC, Andersson and Frykblom (1999).

In order to illustrate our point, let us consider three consumption possibilities for the consumer; the consumer can buy eggs produced from (i) battery cage production systems (x_1), (ii) free range systems when battery cages are not banned (x_2) and (iii) free range systems when battery cages are banned (x_3). Each of these alternatives is associated with a vector of characteristics, t_i (i = 1, 2, 3), that describe the quality of the product and a vector of characteristics, m_i, that describe the private animal welfare cost of the product. Each of the alternatives is also associated with a disutility due to others' consumption, the SAWC. For notational simplicity let us assume that only battery caged eggs have a SAWC, denoted, s_1. These three alternatives are exclusive and we do not model the decision on how many eggs to buy, for simplicity one can assume that they can only be purchased in fixed quantities.[1] The utility function is written

(1) $$U(x_1, x_2, x_3, t_1, t_2, t_3, m_1, m_2, m_3, s_1, z)$$

where z is a numeraire. The individual maximizes the utility function subject to the budget constraint

(2) $$p_1x_1 + p_2x_2 + p_3x_3 + z = y\,,$$

where p_i is the price of good i and y is the income. The individual can only choose one of the goods, so the conditional utility functions are written

$$(3)\qquad u_1 = u(x_1,0,0,t_1,0,0,m_1,0,0,s_1,y-p_1x_1) = v_1(t_1,m_1,s_1,y-p_1x_1)$$

$$u_2 = u(0,x_2,0,0,t_2,0,0,m_2,0,s_1,y-p_2x_2) = v_2(t_2,m_2,s_1,y-p_2x_2)$$

$$u_3 = u(0,0,x_3,0,0,t_3,0,0,m_3,0,y-p_3x_3) = v_3(t_3,m_3,y-p_3x_3)$$

If we are interested in estimating the WTP to eliminate the external effect of battery cages, the relevant comparison is between x_2 and x_3, since $t_2 = t_3$ and $m_2 = m_3$. The only difference between these two cases is the external cost of others consumption of eggs from battery eggs. A comparison of x_1 and x_2 or x_1 and x_3 would capture other aspects than the SAWC of battery caged eggs. While these comparisons still can be of interest, it would not give information whether battery cages in egg production is a source of market failure.

Testing for the presence of market failure

The choice of valuation method

A number of monetary valuation studies have been applied to the question of battery cage versus free range systems, where most have used the contingent valuation method (CVM) to collect responses, see Bennett and Larsson (1996), Bennett (1997) and Rolfe (1999). A CVM survey provides the surveyor with a point value estimate of a good with a certain combination of attributes, such as color, shape, free range etc. It is difficult or expensive to estimate the value of individual product attributes. Each change of an attribute requires a new CVM scenario to value, for example, Andersson and Frykblom (1999) use an experimental design with two identical surveys, where only the type of free range production system differs. If the estimates, as sometimes alleged, are biased, one might assume that the biases do not differ systematically between the survey versions. Consequently, an advantage of such a design is that a comparison of estimates between the two surveys is less vulnerable to the hypothetical nature of the CVM and other potential biases. An alternative to the CVM is the hedonic pricing method, an approach that allows for a valuation of individual attributes. It has the additional benefit of being based on real economic commitments, see e.g. Yen, Jensen and Wang (1996). Nevertheless, the approach cannot be used to measure the value of reduced externalities, as complementarity is required between the good and the externality.

As a response to the shortcomings of other methods, we chose to use a choice experiment for testing the presence of market failure. In a choice experiment, individuals are given a hypothetical setting and asked to choose their preferred alternative among several alternatives in a choice set. The participants are usually asked to perform a sequence of such choices. Each alternative is described by a number of attributes or characteristics. For overviews of choice experiments, see Alpizar, Carlsson and Martinsson (2003) and Louviere, Hensher and Swait (2000).

This survey method thus allows us to estimate the marginal rate of substitution between different attributes, existing as well as hypothetical. Furthermore, a comparison of the WTP for different attributes within the same survey not only implies a possibility for a theoretically correct test of externalities, it also has the advantage of parallel surveys mentioned above.

The choice experiment

A number of steps were taken to design a questionnaire that was policy relevant, plausible and meaningful to the respondent. First, industry representatives and academic researchers specialized on poultry and egg production were consulted and involved in the process of developing the questionnaire. This was followed up by focus groups, where the participants were asked to fill out the questionnaire and write down eventual questions or comments. The focus group participants also took part in a round-table discussion of the questionnaire. The results of these focus groups were returned to the individuals and organizations that participated. This iterative process was repeated three times.

The resulting questionnaire consists of three parts. The first includes questions about the respondent's and the household's habits regarding food consumption. The choice experiment constitutes the second part and questions regarding the respondent's socio-economic status the third part.

In the introduction to the choice experiment, the purpose of the survey was briefly explained. This was followed by a description of the different attributes. The respondents were also provided with a separate fact sheet providing a description of each of the attributes. The attributes are presented in Table 1 and an example of a choice situation is presented in the appendix.

>>>>> Table 1

In the choice experiment, each respondent answered three choice sets. In each set they were asked to choose between three alternatives: one opt-out alternative and two generic alternatives. In the opt-out alternative all attributes were set to the first level in the table above and the price was the same as the current price for a half dozen of battery cage eggs, approximately SEK 9.[2] The attribute levels were varied independently in the two other alternatives and there was no specific alternative labeling of these two.

The choice sets were created using a cyclical design principle (Bunch, Louviere and Andersson 1996). A cyclical design is a straightforward extension of the orthogonal approach. First, each of the alternatives from a fractional factorial design is allocated to different choice sets. Attributes of the additional alternatives are then constructed by cyclically adding alternatives into the choice set based on the attribute levels. The attribute level in the new alternative is the next higher attribute level to the one applied in the previous alternative. If the highest level is attained, the attribute level is set to its lowest level. These two alternatives are then compared with a constant base alternative in each choice set.

Economic and econometric specification

Assuming a linear indirect utility function, the utility of alternative *i* in choice situation *t* for individual *k* is

(4) $$V_{itk} = \beta' a_{it} + \lambda(y_k - \cos t_{it}) + \varepsilon_{itk}$$

where a_i is the attribute vector, β is the corresponding parameter vector and ε_{itk} is an error term. From this specification the mean marginal willingness to pay for a certain attribute is the ratio of the attribute coefficient and the cost coefficient, λ, (Hanemann, 1984).[3] The probability that individual k will chose alternative *i* can be expressed as

(5) $$P_{itk} = P\{\beta' a_{it} + \lambda(y_k - \cos t_{it}) + \varepsilon_{itk} > \beta' a_{jt} + \lambda(y_k - \cos t_{jt}) + \varepsilon_{jtk} >; \forall j \neq i\}$$

In the analysis of the responses, a random parameter logit model is applied. In such a model, taste variation among individuals is explicitly treated (see e.g. Train 1998, 2003). A random parameter logit model is a generalization of a standard multinomial logit. The advantages of a random parameter logit model are that (i) the alternatives are not independent, i.e. the model does not exhibit the independence of irrelevant alternatives property and (ii) there is an explicit account for unobserved heterogeneity. However, an application of a random parameter model is not straightforward since decisions about which parameters that are to be random and the distribution of the random parameters have to be made. Since the main purpose of the investigation is to estimate marginal WTP, the cost attribute is kept fixed, mainly because the distribution of the marginal

WTP for an attribute is the distribution of the attribute. Furthermore, to restrict the coefficient for the cost attribute to be non-positive for all respondents, a normal distribution is not recommended. A lognormal distribution, which would restrict the sign of the variable, can result in extremely high WTP estimates, since values of the cost coefficient close to zero are possible (Revelt and Train, 1998). In order to determine which attribute coefficient to treat as random, a test proposed in McFadden and Train (2000) is applied. With this test artificial variables are constructed from a standard logit estimation

$$(6) \qquad z_{it} = \left(a_{it} - \sum_{j \in C} a_{jt} P_{jt} \right)^2$$

where P_{jt} is the conditional logit probability and C is the choice set. The logit model is then re-estimated with these artificial variables and the test of whether a coefficient should be fixed or not is based on the significance of the coefficient of the artificial variable; see McFadden and Train (2000). Applying this test to our data, it is found that only the intercept should be randomly distributed. The model estimated is thus similar to a random effects model. Finally, a specific distribution of the randomly distributed intercept needs to be specified. Since there is no reason to restrict the coefficient to be non-negative a log-normal distribution can be ruled out. Three other distributions are available in Limdep 8.0: a normal, a triangular and a uniform distribution. The choice between these three distributions does not seem to be as critical as the choice between these or a log-normal distribution (Hensher and Greene, 2003) and this is also the case with our data. One simple approach for receiving some guidance on the choice of distribution is presented in Hensher and Greene (2003). With this approach the standard logit model is estimated N times, with N-1 respondents, where N is the total number of respondents. So for each estimation one individual is removed from the sample. A visual inspection of a plot of the N coefficient estimates, for each attribute, will then reveal information about the distribution of the unobserved heterogeneity. One way of analyzing the coefficient vector is to use a kernel density estimator (Hensher and Greene, 2003). Figure 1 reports the results of the kernel density estimator, with a logit kernel, for the intercept.

>>> Figure 1

From Figure 1 it is seen that a log-normal and uniform distribution can be ruled out. The distribution resembles more a triangular distribution than a normal, so it is assumed that the intercept has a triangular distribution with mean b and spread s. Therefore, the density starts at b-s and ends at b+s.

Results

The population that the sample was drawn from was defined as those between 18 and 75 years with a permanent address in Sweden. A random sample of 800 individuals was selected from the Swedish census registry. A mail survey was conducted in October 2002, two reminders were sent out within a two-week interval to those that had not replied. In total 461 (58%) individuals returned the questionnaire, of which 450 were available for analysis, due to non-responses to various questions. Not all of these answered all three choice sets, however, we still chose to include these individuals in our estimations. In Table 2, the descriptive statistics of the sample used in the estimations are presented.

>>> Table 2

The random parameter logit model is estimated with Limdep 8.0. The model is estimated with simulated maximum likelihood using Halton draws with 250 replications, Train (2003) provides details on simulated maximum likelihood and Halton draws. In addition, to allow for heterogeneity in terms of a random parameter we also include a set of socio-economic characteristics. These are interacted with a randomly distributed constant. Finally, when estimating the model, the information of repeated choices is used, i.e. that we observe one individual in three choice sets. This is done in a simple fashion where the utility coefficients vary across individuals, but are constant across the choice situations for each individual. There is an underlying assumption of stable preference structures for all individuals (Train, 1998). The results of the random parameter logit model are presented in Table 3, as is a comparison the results of a standard multinomial logit model.

>>> Table 3

The random parameter logit model has a substantially higher pseudo-R^2 than the standard multinomial logit model. At the same time, there a few differences between the two models in terms of sign and significance of the parameter estimates. All the attributes included in the choice experiment are significant. The alternative-specific constant for the opt-out alternative is negative implying that, all else equal, respondents prefer one of the new alternatives. The spread of the triangular distribution of the constant although, is large. The estimated coefficients of the attribute are large relative to the size of the cost parameter. This taken together with the size and sign of the constant indicates that respondents by in large prefer the improved alternatives. This can also be seen from the descriptive statistics in Table 2. The hypothetical nature of the experiment makes it likely that the estimated levels of the marginal WTP may be overestimated. The existence of hypothetical bias in choice experiments have been tested and rejected by Carlsson and Martinsson (2001). Lusk and Schroeder (forthcoming) conclude, however, that although total WTP is overstated in hypothetical experiments, the marginal WTP is not. Even if there is a hypothetical bias in marginal WTP, our main interest is in the relative magnitude of the estimated WTP for the two free range attributes. As discussed earlier, the marginal WTP is the ratio of the attribute coefficient and the cost coefficient. The marginal WTP's and the difference in WTP between the two attributes are presented in Table 4, together with the corresponding 95% confidence intervals. The confidence intervals are based on standards errors estimated with the delta method.

>>> Table 4

The estimated WTP for the two production alternatives are high, the current market price premium is around $.35 for a half dozen of eggs from a free range system. Similar to the previous literature, we do find a significant WTP for eggs produced in a free range system when cages are banned. As pointed out earlier, we believe that this is not a sufficient reason for a ban of cages. The relevant comparison is between the WTP for the two types of free range eggs. This reveals a lower WTP for the market solution than for the regulation solution, and the difference in WTP is non-negligible. However, the difference is not significant at any conventional level. Based on these results we can therefore not say that a ban of battery cages would reduce negative external effects from egg production.

Discussion and conclusion

Our food becomes increasingly heterogeneous as public demand has resulted in alternatives such as organic and locally produced. Some of these goods are a response to concerns over conventional production of farm livestock. The debate over farm animals has so far been relatively more intensive in Australia and Europe, but there are also increased concerns in the United States. If there are negative externalities in the way farm animals are treated, there are arguments for imposing restrictions in the production. Before any kind of policy instrument is implemented though, it needs to be empirically tested whether there actually exists a negative externality. If no such externality can be found, the economically efficient policy is to have the consumers make the trade-off between different products and prices.

We argue that previous studies have not been able to measure the negative externality of farm animal welfare in a proper way. We use a choice experiment with a design where the external effect is isolated. In applying it to the question of battery cages versus free range systems in egg production, we find that there is a difference in the WTP between the market and regulation solution. The difference is, however, not significant and does not justify a ban of battery cage production. The wider policy implications are applicable not only to the question of egg production, they can be extended to a general discussion of how potential market failures for all types of farm livestock should be managed.

A possible explanation of our results can be found in a hypothesis by Hamilton, Sunding and Zilberman (2003). They argue that preferences for public goods also may include an aversion against a loss of options. Our results would then measure the net effect of the eliminated externality and the loss of an option value. Their hypothesis does not change any of the conclusions or implications though, as a ban inevitably results in a loss of options.

A general critique of using consumers to determine livestock management is that they are not the only ones to have preferences over the welfare of animals. Individuals might have chosen to not consume livestock commodities for a number of reasons, including ethical related concerns. Since our survey has not considered this group of individuals, we might have underestimated the benefits of a ban. This is a testable empirical question not unique to this survey, it is applicable to all previously published empirical economic work surveying consumers' demand for animal welfare improvements. It is definitely a question that deserves future attention.

Further empirical and theoretical work to investigate the robustness of our results is warranted. For example, what are the implications of using mean values when individuals can be expected to have heterogenic preferences and endowments? How does information affect the acceptance of an increasingly more heterogenic food market? We leave these and other questions to future work.

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Endnotes

1. The exposition is simplified, but not to the extent that it would affect the general implications of the present study.

2. At the time of the experiment, US $1 = SEK 10.

3. When the model is estimated the income variable drops out since only differences in utility affect the choice probabilities.

Appendix. Example of a choice situation

Before you chose any alternatives, you should now read the fact sheet.

Choice 1, eggs

Attributes eggs	Eggs 1 (base alternative)	Eggs 2	Eggs 3
Fodder	The fodder fulfills current policy	The fodder fulfills current policy	Guarantee of no GMO in fodder
Animal husbandry	Battery cage	All eggs produced by hen in free range systems	Your eggs are produced by hen in free range systems, though battery cages are still allowed
Omega 3	The eggs are not Omega-3 enriched	The eggs are Omega-3 enriched	The eggs are Omega-3 enriched
Country of origin	Other EU country than Sweden	Other EU country than Sweden	Sweden
Additional cost SEK/half dozen	SEK 0	+ SEK 3	+ SEK 1.50
(total cost)	(SEK 7)	(SEK 10)	(SEK 8.50)
Your choice (mark one alternative)			

Table 1. Attributes and levels

Attribute	Levels
1. GMO	1.1 Current policy. A producer is allowed to use GMO if it can be shown to be harmless
	1.2 A ban on genetically modified fodder
2. Omega 3	2.1 Not enriched with Omega 3
	2.2 Enriched with Omega 3
3. Origin	3.1 Produced within the European Union, but not in Sweden
	3.2 Produced in Sweden
4. Production system	4.1 Produced in a battery cage system
	4.2 Produced in a free range system, battery cages are still allowed
	4.3 Produced in a free range system, battery cages are banned

Table 2. Descriptive statistics observations included in final estimations

Variable	Description	Mean	Std.	Min	Max
Female	= 1 if respondent is a female	0.509	0.500	0	1
Age	Respondent's age	55.12	15.66	0	75
Kids	= 1 if at least one household member under age of 20	0.369	0.483	0	1
Family size	Number of household members	2.517	1.263	0	8
Responsible for food purchase	= 1 if respondent is the main responsible person for food purchase in household	0.420	0.494	0	1

Responses in choice experiment	Number
Alt 1. Opt-out	82
Alt. 2	582
Alt 3	565

Table 3. Multinomial and random parameter estimates.

	Multinomial logit		Random parameter logit	
	Coefficient	P-value	Coefficient	P-value
Fixed parameters				
Constant	-0.1783	0.725		
Cost	-0.0737	0.003	-0.0916	0.001
1.2 No genetic modification of fodder	0.2328	0.004	0.2519	0.006
2.2 Omega 3 in fodder	0.2215	0.008	0.2153	0.017
3.2 Swedish	1.7243	0.000	1.7896	0.000
4.2 Free range legal	0.9031	0.000	0.9930	0.000
4.3 Free range market	0.6949	0.000	0.7692	0.000
Random parameter				
Constant: Opt-out			-4.9761	0.026
Spread of parameter distribution				
Constant: Opt-out			13.503	0.000
Socio-economic characteristics / Heterogeneity in mean				
Female	-1.3234	0.000	-3.5594	0.003
Age	-0.0027	0.711	-0.0281	0.438
Kids	-1.3887	0.002	-3.8694	0.021
Family size	0.2540	0.086	0.8513	0.132
Responsible for food purchase in household	0.8360	0.002	2.0119	0.050
Log-likelihood	770.75		695.95	
Psuedo-R^2	0.29		0.48	

Table 4. Marginal willingness to pay (SEK/half dozen) and 95% confidence intervals.

	Marginal willingness to pay
Free range legal	10.84
(battery cages are banned)	(4.35-17.33)
Free range market	8.40
(both types of eggs are marketed)	(2.99-13.80)
Difference in marginal WTP	2.44
(Free range legal – Free range market)	(-0.60-5.48)

Figure 1. Kernel density estimate