

The animal welfare cost of meat: evidence from a survey of hypothetical scenarios among Belgian consumers

Abstract

A survey in Belgium with hypothetical scenarios concerning willingness to pay to avoid the experiences of farm animals is used to estimate the animal welfare costs of meat production. Most participants indicate that farm animals have lives not worth living. The median estimate of the animal welfare cost of chicken meat is 10 euro/kg, whereas its mean estimate is several orders of magnitude higher. The animal welfare costs of meat are likely much larger than the consumer utility of meat consumption, the consumer willingness to pay for higher animal welfare meat and the climate/environmental costs of meat. A demand shift from beef to chicken meat due to misaligned consumer concerns for animal welfare or a carbon tax on meat, could possibly increase animal welfare costs and decrease the non-anthropocentric social welfare function. Consumers could prioritize lowering chicken meat consumption and governments could implement a flat tax on meat.

Keywords: animal welfare; meat; optimal tax; welfare economics; willingness to pay

Introduction

Animal welfare economics is a relatively new research discipline that integrates animal welfare in welfare economics (Fearing & Matheny, 2007; Lusk & Norwood, 2011, 2012; Carlier & Treich, 2020; Espinoza, 2022). Traditional welfare economics is anthropocentric, as it considers only the welfare, preferences or utilities of humans. The utility function of a human represents that person's preferences, and those preferences can describe or explain the behavior or the choices made by that human. Humans have a preference for their own welfare, and hence welfare appears in the human's utility function. But humans can also value the welfare of others. That means in anthropocentric welfare economics, non-human animals (animals for short) are only valued indirectly, as humans may have a preference for animal welfare. This indirect valuation means that animal welfare appears in the utility functions of humans.

However, the behavior of animals can also be described by the animals having preferences themselves. Animals have a preference for their own welfare. Unfortunately, animals cannot directly state their preferences to us. They cannot tell us whether they have a positive welfare or a life worth living. This information problem may be one of the reasons why the utilities of animals are excluded from usual cost-benefit analyses in welfare economics. Excluding animals implies the costs of animal suffering are underestimated.

Whether to include animal utilities in welfare economics becomes particularly relevant in the case of animal farming and meat consumption. The preference of humans for animal welfare can express itself as a higher willingness to pay for meat that comes from farms with higher animal welfare standards. This willingness to pay represents the anthropocentric animal welfare costs from the perspective of the human. Efficient markets can incorporate these anthropocentric animal welfare costs in the price of meat and arrive at an anthropocentric

Pareto efficient level of meat consumption that in a sense maximizes the benefit-cost ratio.

The Pareto efficiency means that no human can be made better off without making another human worse off.

The notion of Pareto (or Kaldor-Hicks) efficiency cannot be straightforwardly applied to animals, because animals cannot transfer wealth to humans. Animals cannot pay and hence do not have a willingness to pay for welfare improvements. Furthermore, the market determines how many farm animals are born. It is conceptually difficult to say that an individual in one situation is better-off than in another situation in which that individual does not exist. Hence, Pareto efficiency is ill-defined in a case like animal farming.¹ Nevertheless, if animals are included in a social welfare function, a notion of optimality is applicable to animal welfare. A market that includes animal farming may not be welfare optimizing when farm animals have lives full of suffering, i.e. lives not worth living. If animals live lives that are not worth living, the welfare value of bringing them into existence for our benefit is negative. But the animal welfare costs experienced by the animal are not reflected in the market prices of meat. These animal welfare costs are external costs, not internalized in the price. This results in a market failure: the market equilibrates at a state that is welfare optimizing for both humans and animals together. The external animal welfare costs could even outweigh the human benefits of meat consumption.

A social planner who wants to maximize a social welfare function, has to decide whether or not to incorporate the utilities of animals in the social welfare function directly, instead of merely indirectly through the human utilities. The human valuation of animal welfare, expressed in the human utilities incorporated in the social welfare function, may not capture the total animal welfare. The social planner may have a low credence about including animal

¹ For further discussion on this, see 'the logic of the larder' (Matheny & Chan, 2005) and the literature on population ethics (Parfit, 1984; Greaves, 2017).

utilities directly. But given the fact that for example tens of billions of livestock chickens, pigs and cows are born and killed every year globally, even a small probability that animal utilities should be included in the social welfare function can drastically affect the social planner's decisions.

This study tries to estimate the external animal welfare costs, using a survey performed in Belgium. As a contingent valuation method, the survey contains a set of hypothetical questions about the willingness to pay (WTP) to avoid having the experiences of a farm animal and the willingness to accept (WTA) an amount of money for getting the experiences of a farm animal. A positive WTP or WTA means that the respondent wants to avoid the animal's experiences, which could be interpreted as a belief that the farm animal has a life not worth living (i.e. with a negative utility). This WTP and WTA are measures of the external animal welfare costs.

The results show that the external animal welfare cost of chicken meat can become substantially larger than the consumer benefit of meat consumption, measured in terms of their willingness to pay for meat. Due to a cow producing more meat than a chicken, the external animal welfare cost for a kilogram of chicken meat is more than two orders of magnitude larger than for beef. These animal welfare costs are not aligned with consumer preferences for animal welfare: the marginal willingness to pay for meat with higher animal welfare standards or meat without animal suffering is larger for beef than for chicken meat, indicating that consumers are more concerned about cow welfare than chicken welfare.

Hence, consumers who value animal welfare, might switch from beef to chicken meat, but by doing so they increase the external animal welfare costs. Similarly, beef production has a higher climate and environmental impact. A Pigouvian carbon tax increases the price of beef more than the price of chicken meat. As was argued by Kuruc and McFadden (2020), this differential price increase could cause a similar demand shift from beef to chicken, increasing

the external animal welfare costs. In other words, if there are multiple external costs, a partial internalization of external costs (for example only internalizing climate change costs) with a Pigouvian tax could increase the non-internalized external costs even to such a degree that the total external costs increase. The aim of the present study is to give a better estimate of the change in external costs of animal welfare when a carbon tax on meat is introduced.

Theoretical framework

Non-anthropocentric social welfare function

A possible starting point for animal welfare economics is the utilitarian non-anthropocentric social welfare function (examples are used in e.g. Blackorby & Donaldson, 1992; Lusk & Norwood, 2012; Johansson-Stenman, 2018; Espinosa & Treich, 2021). For our analysis this function can be expressed as the sum of utilities over all N_H humans and N_A animals who exist in a certain time period:

$$W = \sum_{h=1}^{N_H} U_h(C_h, M_h, \{W_a\}, P_h) + \sum_{a=1}^{N_A} \delta_a U_a(W_a).$$

The utility U_h of human h in the concerned time period depends on that person's consumption of an amount of meat M_h (which has a price p_M), the consumption of a composite marketable good (excluding meat) C_h (which has price $p_C = 1$ such that C_h is measured in euros), the welfare of the animals $\{W_a\}$ and everything else that the human prefers, such as non-marketable goods (captured by the term P_h). The animal welfare W_a is an aggregate of the animal's physical and mental health, positive minus negative experiences, and other attributes. The dependence of the human utility on the animal welfare values $\{W_a\}$ reflects an altruistic preference of the human for animal welfare, or an instrumental valuation of animal

welfare by the human (Johansson-Stenman, 2018). As animals value their own welfare, the animal utility U_a is an increasing function of the animal welfare W_a , whose form will not be further specified here. The animal discount factors δ_a measure the relative importance of a unit of utility of animal a to a unit of human utility. If $\delta_a = 0$, we get the traditional anthropocentric social welfare function that only includes the utilities of humans. The animal discount factors can also be interpreted as weighting constants to make animal and human utilities interpersonally comparable. For simplicity, and to avoid speciesism (unequal consideration of equal interests of humans and animals (Singer, 2002; Espinosa & Treich, 2021)), I shall assume $\delta_a = 1$.

The social planner maximizes the above social welfare function under a set of constraints.²

Monetary animal welfare measures

The human demand for meat can be expressed as the willingness to pay (or compensating variation) for meat, defined by the indifference between a lower consumption of the composite good and a zero consumption of meat:

$$U_h(C_h - WTP_h^M, M_h, \{W_a\}) = U_h(C_h, 0, \{W_a\}),$$

with WTP_h^M the human h 's willingness to pay for meat. This WTP is the maximum amount of money that the consumer is willing to buy for an amount M_h of meat. The average willingness to pay is expressed as:

$$AWTP_h^M = \frac{WTP_h^M}{M_h},$$

² Constraints include the budget constraint $\sum_h (C_h + p_M M_h) \leq \sum_h I_h$, with I_h the disposable income of the human in the concerned time period, and the meat production constraint $\sum_h M_h \leq \sum_a m_a$, with m_a the amount of edible meat produced by animal a .

and the marginal willingness to pay is measured as the slope of the indifference curve (C_h as a function M_h at constant utility):

$$MWT P_h^M = - \left. \frac{dC_h}{dM_h} \right|_U = \frac{\partial U_h / \partial M_h}{\partial U_h / \partial C_h}.$$

In an efficient market equilibrium, the marginal WTP equals the price of meat. The average WTP can be interpreted as the monetized consumer utility of meat consumption, i.e. the utility expressed in monetary terms.

With the animal utilities in the social welfare function, we can construct monetary animal welfare measures. First, we can define the consumer marginal WTP for animal welfare:

$$MWT P_h^{W_a} = \frac{\partial U_h / \partial W_a}{\partial U_h / \partial C_h}.$$

This is the maximum amount of money that human h is willing to spend to increase the welfare of animal a by one unit. This animal welfare measure only captures the instrumental valuation of animal welfare, i.e. the animal welfare appearing in the human utilities. In contrast, the external welfare costs of animal suffering represent the intrinsic valuation of animal welfare, due to the extra animal utility terms in the non-anthropocentric social welfare function.

If a farm animal suffers so much that it has a life not worth living (Espinosa & Treich, 2021), it is defined as having a negative utility $U_a < 0$. This negative utility can be expressed in monetary terms as an external animal welfare cost as follows. First, note that the social welfare function contains the sum of the utilities of humans and animals. Consider for simplicity one human (index H) and one (farm) animal (index A). The combined utilities of these two individuals in the social welfare function can be reinterpreted as the extended utility of a representative agent, i.e. the utility function of one hypothetical individual who experiences both the lives of the human and the animal. As the utilities are summed together

in the social welfare function, the extended utility is represented as an additively separable utility function:

$$U_H^{ext}(C_H, M_H, \{W_a\}, U_A) = U_H(C_H, M_H, \{W_a\}) + U_A.$$

Second, note that for this hypothetical representative agent, the utility of the animal is fully internalized, which means that the animal welfare cost can be expressed as a willingness to pay according to the indifference:

$$U_H^{ext}(C_H, M_H, \{W_a\}, U_A) = U_H^{ext}(C_H - WTP_H^A, M_H, \{W_a\}, 0)$$

or

$$U_H(C_H, M_H, \{W_a\}) + U_A = U_H(C_H - WTP_H^A, M_H, \{W_a\}).$$

This defines the representative agent WTP, not to be confused with the abovementioned consumer WTP for animal welfare. The left hand side represents the situation where both the human and animal exist, the right hand side corresponds with non-existence of the animal.³

This non-existence defines the state of zero utility. If the animal has a negative utility, the representative agent is maximally willing to pay WTP_H^A in order to avoid experiencing the life of the animal. A similar indifference relation defines the representative agent willingness to accept (WTA), i.e. the minimum amount of money the representative agent wants to receive in order to experience the life of the animal:

$$U_H(C_H + WTA_H^A, M_H, \{W_a\}) + U_A = U_H(C_H, M_H, \{W_a\}).$$

³ Strictly speaking, this is not entirely correct: the representative agent can still instrumentally value animal welfare, due to the human utility function containing the animal welfare values $\{W_a\}$. This set of animal welfare values may or may not include the welfare W_A of the one concerned animal. If in the right hand side of the indifference equation, the set $\{W_a\}$ contains W_A , it is as if the human still believes that animal A exists and has welfare W_A . For the present study, this point of subtlety is of no substantial concern.

Methodology

Survey

The external animal welfare costs of animal farming are estimated using contingent valuation. A trial survey was conducted among 170 people (mostly university students). Based on this trial survey, a more extended online survey containing more than 40 questions was distributed by a market research company among an online panel of 500 Flemish speaking Belgian citizens with ages between 18 and 65 years, in June 2022. The participants were selected by an algorithm to have a representative sample of the Flemish population according to gender and age. In the survey introduction, the participants were informed that their data will be processed anonymously. The introduction mentioned that the survey is about the value that people attach to animal welfare.”⁴ No extra information about objectives of the survey were given. The survey contained 44 questions. Median and mean response times were 6 and 11 minutes.

The central set of questions intend to estimate the representative agent WTP and WTA, and are based on a hypothetical situation described in an introductory text: “The questions below are about choices in a very hypothetical situation. Read them carefully and try to think about them as if you were actually faced with those choices.”⁵ Suppose you have to take a colored pill and you have the choice between either a yellow or a blue pill.⁶ If you take the yellow pill, you fall into a long sleep in which you have a lifelike experience that you are an animal that really exists. You experience everything just as that animal experiences things in reality. You feel everything the animal feels during its life, from birth to death. You only think about the things that the animal actually thinks. You remember nothing of your life as a human, and

⁴ The survey was in Dutch. The English quotes in this article are translations by the author.

⁵ This short ‘cheap talk’ disclaimer was added to mitigate hypothetical bias (Morrison & Brown, 2009).

⁶ These colors are assumed to be neutral. Using non-neutral colors such as green and red might bias the results, as these colors might be associated with positive and negative values.

when you wake up again, you will remember nothing of that experience as an animal. If you take the blue pill, you will fall asleep for an equally long period of time, but you will not dream or experience anything. You then only have an unconscious, deep sleep. Both pills have the same taste, are equally healthy, and you won't notice any difference when you are awake.”

With the described conditions, this hypothetical situation intends to elicit the extended utility U_H^{ext} of a representative agent as an appropriate function of the human and animal utilities. In particular, the condition of having no memories ensures that the extended utility is additively separable in the real utility of the respondent (the human) and the imagined utility of the animal. The condition that the experience is lifelike⁷ and present⁸ ensures that there is no animal utility discounting (i.e. $\delta_a = 1$).

This introduction text is followed by a test question to check whether respondents have read and understood the text. Next, the respondents answer a set of questions (in a randomized order for different respondents), according to six kinds of animals: “Suppose the yellow pill lets you experience the life of [animal]. Which pill would you prefer?”, where [animal] is one of the following descriptions.

- A broiler chicken in conventional poultry farming.
- A meat pig in conventional pig farming.
- A beef cow in conventional cattle farming.

⁷ Another hypothetical situation is dreaming, where a person dreams of being an animal. However, dream states might seem less realistic or vivid, which means the experiences of suffering in a dream are discounted.

⁸ Another hypothetical situation is reincarnation, where a person imagines in the future, after one's death, being reincarnated as an animal (again with no memories of the previous human life, to ensure separability of utilities). However, a problem of this approach is that respondents might have a time preference, which means they might discount future utility. This temporal discounting implies that the animal's utility is discounted with a factor $\delta_a < 1$.

- A broiler chicken in a poultry farm that has a reliable animal welfare label (the chickens have sufficient space, free range, opportunities for foraging, distraction material, limited transport time to the slaughterhouse and no growth disorders).
- A welfare neutral animal that has no positive or negative experiences. It has no happy experiences, but also no suffering. Everything is neutral for this animal.
- The happiest animal imaginable, which is perfectly healthy, never suffers and is always able to eat, exercise, play and exhibit natural behavior.

A first follow up question elicits the monetary value of the animal's utility in terms of the WTP or WTA. Respondents were randomly assigned one of two conditions. The WTP-condition asks the question: "Suppose your preferred pill is more expensive than the other. The other pill is free, whereas you have to pay for your chosen pill. What is the maximum amount of money you would be willing to pay for that pill?" The WTA-condition asks the question: "Suppose you would receive money if you take the other pill that you did not prefer. What is the minimum amount of money you would like to receive for you to take that other pill?" If the respondent prefers the blue pill, the WTP [WTA] is positive and represents the maximum [minimum] amount of money that the respondent is willing to pay [willing to receive] in order to avoid experiencing [to experience] the life of that animal. If the respondent prefers the yellow pill, the WTP [WTA] is negative and represents the maximum [minimum] amount of money that the respondent is willing to pay [willing to receive] in order to experience [to not experience] the life of that animal. Hence, a positive WTP [WTA] can be interpreted as the life of the animal having a negative contribution to the social welfare function as represented by a representative agent. If the WTP [WTA] for the welfare neutral animal is zero, a positive WTP [WTA] indicates that the life of the animal is considered not worth living (or rather not worth experiencing).

As the situations are very hypothetical, we can expect a large hypothetical bias (Murphy, e.a. 2005; Guzman & Kolstad, 2007). The use of certainty scales can mitigate this bias (Morrison & Brown, 2009; Ready, Champ & Lawton, 2010). Hence a second follow up question asks about the respondent's certainty scale or confidence level to the preceding WTP/WTa response (ranging from "0% - absolute uncertain" to "100% - absolute certain").

The consumer marginal WTP for animal welfare ($MWTP_h^{W_a}$) is surveyed using two questions, in randomized order, based on the following description: "Suppose that meat producers with a new production method can produce meat without animal suffering. Consider, for example, cell-based or cultured meat where only the meat cells instead of the entire animals are grown. Suppose that animal-free, cruelty-free meat is the same as conventional meat in all other respects: it is just as expensive and just as harmful to the environment. Because the same muscle cells are involved, the animal-free, cruelty-free meat tastes just the same as conventional animal-based meat and has just the same nutritional value. People can reduce a certain amount of animal suffering by replacing an amount of animal-based meat with cruelty-free meat. Suppose this replacement costs extra money. What is the maximum amount that you are willing to pay extra for a kilogram of cruelty-free [chicken, pig, cow - in randomized order] meat?" This question may elicit a social desirability bias (resulting in an overestimation of the marginal WTP), as respondents can use it to signal their own concern for animal welfare. To avoid this bias, a second, reframed question asks how much the respondent thinks a random person in Belgium⁹ is willing to pay extra for cruelty-free meat. However, this question faces an information bias, as people may systematically under- or overestimate other

⁹ Instead of asking for the respondent's own WTP, the respondent answers for a random person. As the respondent is not able to signal one's concern for animal welfare, this chosen framing of the question is expected to mitigate a social desirability bias in responses.

people's preferences for cruelty-free meat. A certainty scale question is added to mitigate this information bias.

The survey also contains a set of eight questions that probe for the respondent's knowledge about farm animal living conditions (e.g. "How many live born piglets die in pig farms within the first weeks of their life?" "How many chickens live on a square meter in conventional broiler farms?") and animal mental capacities (e.g. "True or false? Chickens have no self-control and always choose the short-term reward rather than a bigger reward later." "Cows become more pessimistic about uncertain rewards when they are in a painful, stressful or lonely situation.")). These questions are intended to measure respondent's over- or underestimations of farm animal suffering.

The survey concludes with demographic questions (gender, age, highest education degree, income on an ordinal scale), dietary preferences (eating meat, vegetarian, vegan), and levels of engagement for animal welfare (ordinal scale, with examples such as signing petitions).

Central tendency estimates of WTP and WTA

The data show highly skewed (non-normal) distributions for the WTA and WTP. Due to this skewness, both the median and the mean are calculated. The reported means are the weighted means, weighted by the respondent's confidence levels (certainty scales).

Concerning the representative agent WTP and WTA, both an absolute and a relative value are estimated. The relative WTP to avoid the experiences of an animal is the stated (absolute) WTP of that animal minus the stated WTP of the welfare neutral animal. The reason for calculating a relative WTP, is the possibility that respondents simply dislike getting experiences of an animal, even if it consists only of welfare neutral experiences. Respondents might have an aversion to seeing life through another's perspective. Or they may think that

they lose their human identities when they take the yellow pill, and they may have a preference for keeping their identity. As a consequence, even for the welfare neutral animal, respondents may have a positive WTP to avoid its experiences. Hence, a zero absolute WTP does not necessarily correspond with welfare neutrality or zero utility. The relative WTP could be interpreted as measuring the animal utility relative the zero level.

Exclusion criteria

500 respondents started the survey, of which 301 completed the survey and answered the test question correctly. Not all these responses are equally valid. To include only the most reliable responses for the analyses of the representative agent WTP-WTA, three exclusion criteria were used.

First, N=61 respondents who gave at least one inconsistent answer were removed.

Inconsistencies include:

1. having a strictly higher WTP (or WTA) to avoid the experiences of the happiest animal than to avoid the experiences of the other animals, and
2. having a strictly higher WTP (or WTA) to avoid the experiences of a broiler chicken raised on a 'better life' farm than to avoid the experiences of a broiler chicken on a conventional poultry farm.

Second, for the calculation of the representative agent mean WTA, N=5 outliers were removed. The data showed that especially the WTA questions contain some outliers.¹⁰

Outliers were determined by ranking the respondents according to increasing (absolute value

¹⁰ The highest WTA was 10^{14} euro, about as much as global GDP. This is much higher than the highest WTP of 25.000 euro.

of) WTA.¹¹ If the WTA of a respondent is more than ten times higher than the WTA of the adjacent lower ranked respondent, then the respondent and all its higher ranked successors are considered outliers. According to the data, 1.000.000 euro happens to be a useful cut-off for this truncation.

Third, for the representative agent median WTA and WTP estimates, N=120 respondents who have confidence levels lower than the median confidence level (which is close to 66%) were excluded.¹² Results with inclusion of all low confidence people are presented as a sensitivity analysis.

Results

Of the N=301 respondents, 50% are female, 51% have a higher education (graduate school or university) diploma, 4% do not eat meat, 54% have engaged with animal welfare or animal rights to some degree (i.e. signed petitions). In terms of farm animal welfare knowledge, 51% of respondents have a positive score indicating an overestimation of farm animal suffering, whereas 49% show an underestimation of the problem. The median age and monthly household income are 43 years and 3500 euro respectively.

The majority of participants gave a positive relative WTA for conventional farm animals, which can be interpreted as having a negative evaluation about the lives of these animals, as if they have lives not worth living (Table 1). In terms of relative WTP, the vast majority (more than four fifths) of respondents assign a zero or negative value to the lives of conventional

¹¹ Correlations between stated WTA and confidence levels are small, with some extreme values having confidence level 100%. Hence, the confidence levels are no good indicators to detect outliers.

¹² The data shows a slight negative correlation between stated WTA and confidence level. People who are less certain about their answers, are more likely to give lower WTA values. Many low confidence people indicated a zero WTA. Hence, using a lower cut-off value for the confidence level than the median, and eliminating responses with confidence levels lower than this lower cut-off, decreases the WTA estimates.

farm animals. Chickens on a ‘better life’ farm are considered better off: roughly one third of the respondents believe that these chickens have positive lives (negative WTA). Most respondents (59%) believe that the happiest animal has a life worth living.

Table 1: Percentages of respondents giving a positive, zero or negative WTP and WTA for six animals.

		Chicken	Pig	Cow	Chicken	Neutral	Happiest	
					better life	animal	animal	
WTA (N=57)	Absolute	Negative	16%	18%	27%	40%	37%	66%
		Zero	12%	19%	12%	20%	25%	25%
		Positive	72%	63%	62%	40%	39%	8%
	Relative	Negative	9%	14%	13%	35%	0%	59%
		Zero	35%	26%	35%	40%	100%	41%
		Positive	56%	60%	52%	25%	0%	0%
WTP (N=66)	Absolute	Negative	23%	23%	28%	41%	41%	53%
		Zero	32%	33%	28%	30%	38%	41%
		Positive	45%	44%	44%	30%	22%	6%
	Relative	Negative	9%	16%	16%	20%	0%	33%
		Zero	58%	50%	48%	59%	100%	67%
		Positive	33%	34%	36%	20%	0%	0%

Note: inconsistent responses and responses with lower than median confidence levels are excluded.

The relative WTA/WTP for the welfare neutral animal is zero by definition, because the welfare neutral animal is considered the reference for the relative measures. A negative WTA/WTP means respondents prefer or would enjoy experiencing the life of the animal.

Table 2 shows the central tendencies (median and mean) of WTP and WTA in euros for avoiding experiencing the life of an animal. These values represent the external animal welfare costs of meat. Conventional farm animals have non-negative mean and median,

absolute and relative WTP and WTA, which means their lives are generally considered not worth living. The happiest animal has mostly negative estimates, indicating a life worth living. The estimates for a ‘better life’ broiler chicken are mixed, with a positive mean relative WTP but a negative mean relative WTA. The median estimates are zero. Hence it is not clear whether a ‘better-life’ broiler chicken is considered having a net positive or net negative welfare life. The neutral welfare animal has some positive absolute mean WTA and WTP estimates, but zero medians, indicating that a minority of respondents have a strong preference not experiencing the life of a neutral animal.

Table 2: External animal welfare costs (euros) according to WTP and WTA for six animals.

		Chicken	Pig	Cow	Chicken	Neutral	Happiest	
					better life	animal	animal	
WTA	Median	Absolute	50	50	50	0	0	-90
	(N=57)	Relative	15	20	2,5	0	0	-25
	Mean	Absolute	79525	15053	45470	1215	9468	-38609
	(N=108)	Relative	69561	19322	39035	-6755	0	-47699
WTP	Median	Absolute	0	0	0	0	0	-1
	(N=66)	Relative	0	0	0	0	0	0
	Mean	Absolute	315	309	313	306	308	-13
	(N=127)	Relative	8	3	8	1	0	-305

Notes: inconsistent responses, outlier responses for mean estimates and lower than median confidence level responses for median estimates are excluded. Positive values indicate a life not worth living or experiencing. An average person would need to be paid 9468 euros to avoid experiencing the life of a neutral animal.

Due to the high non-normality of the data, with large outliers, a non-parametric related-samples Friedman's analysis of variance by ranks was performed to test differences in distributions for the six considered animals. At 5% significance level, the WTA for the happiest animal is strictly lower than for any of the other five animals, and the WTA for the 'better life' broiler chicken and for the neutral welfare animal are consistently lower than for the three farm animals (chicken, pig, cow). A similar pattern, but in many cases with lower significance, is seen for the WTP.

Table 3 expresses the WTP and WTA per kilogram of meat, assuming a broiler chicken, a meat pig and a beef cow have respectively 1.5 kg, 95 kg and 320 kg of edible meat. The mean WTA for a kilogram of chicken meat is around 50000 euro. This is several orders of magnitude higher than the median and the WTP values. It is also highly sensitive to the choice of cut-off point for the removal of outliers.

Table 3: External animal welfare costs (euros) according to WTP and WTA, per kilogram of meat of a farm animal

			Chicken	Pork	Beef	Chicken
			meat			better
						life
WTA	Median	Absolute	33	0,53	0,16	0
	(N=57)	Relative	10	0,21	0,01	0
	Mean	Absolute	53017	158	142	810
	(N=108)	Relative	46374	203	122	-4503
WTP	Median	Absolute	0	0	0	0
	(N=66)	Relative	0	0	0	0
	Mean	Absolute	210.2	3.26	0.98	204
	(N=127)	Relative	5.1	0.03	0.02	0.3

Independent samples Mann-Whitney U-tests were performed to test for differences between groups of respondents. The respondents were divided in groups according to gender (women versus men and other), income (above versus below sample average), age (above versus below 35 years), meat consumption (meat eaters versus vegetarians and vegans) and score of estimation of animal welfare problems based on the respondents knowledge of animal farming and animal mental capacities (underestimating versus not underestimating animal welfare problems). For none of these divisions, significant differences between groups were observed ($p > 0.05$). That means the null hypothesis that there are no differences between the subgroups are retained. These non-significant results are not unexpected, as the sample size is small and the U-test has low statistical power. Similarly, the sample size is too small to study sequencing bias, i.e. the effect of the order of the questions.

Finally, Table 4 shows the consumer marginal WTP for animal welfare, according to three measures. Respondents on average believe that a random person has a marginal WTP for animal welfare (based on the altruistic preferences of that person) of about 7 to 9 euro per kilogram of meat. Beef meat has the highest marginal WTP according to the three measures, chicken meat the lowest. For the own WTP, the differences between the three distributions (for the three animals) are statistically significant according to related-samples Friedman tests ($p < 0.025$). The same goes for the guessed WTP of another, random person ($p < 0.012$).

The same test shows that the own WTP is slightly lower than the guessed WTP of another, random person ($p < 0.045$), indicating that an information bias might be stronger than the social desirability bias.

Surprisingly, there are no statistically significant correlations different from zero between any of the three consumer marginal WTP measures and any of the representative agent WTP and WTA animal welfare costs. The answers people give for what they would be willing to pay

out of their own concern are not correlated with how bad they report animals lives to be in the ‘dream’ scenario. This lack of significant correlation might be due to the low sample size.

Table 4: Consumer marginal willingness to pay measures for animal welfare, per kilogram of meat (euros)

	Own WTP			Guessed WTP of another, random person		
	Chicken meat	Pork	Beef	Chicken meat	Pork	Beef
Median	3.0	3.0	4.0	3.0	4.0	5.0
Mean	7.4	8.5	8.9	8.7	7.1	9.2

Sensitivity analysis

The WTA estimates are highly sensitive to the applied exclusion criteria methods. Table 5 shows the WTA for the full sample (N=113) of consistent responses. For the median, responses with a lower than median confidence are included. For the mean, outliers are included but winsorized at 90% (values below the 5th and above the 95th percentiles are set to resp. the 5th and 95th percentile).

The full sample median estimates are smaller (often zero) and the mean estimates are generally larger (tenfold for pig) than the truncated sample estimates in Table 2. This shows that the WTA results are very sensitive to the exclusion criteria and outlier treatment.

Table 5: Percentages of respondents giving a positive, zero or negative WTA and external animal welfare costs (euros) according to WTA for six animals, using the full sample of consistent responses.

		Chicken	Pig	Cow	Chicken	Neutral	Happiest	
					better life	animal	animal	
Percentages	Absolute	Negative	16%	17%	24%	37%	28%	58%
		Zero	22%	22%	19%	27%	39%	32%
		Positive	62%	61%	57%	36%	33%	10%
	Relative	Negative	9%	11%	15%	33%	0%	52%
		Zero	43%	36%	42%	46%	100%	48%
		Positive	48%	53%	43%	21%	0%	0%
WTA	Median, unweighted	Absolute	20	20	10	0	0	-5
		Relative	0	5	0	0	0	-2
	Median, weighted	Absolute	10	5	3	0	0	-4
		Relative	0	5	0	0	0	-2
	Mean, unweighted	Absolute	232214	817174	211476	1795	3177	-34929
		Relative	229036	813996	208299	-1382	0	-38106
	Mean, weighted	Absolute	294118	1084803	259747	829	4312	-46288
		Relative	290156	1080545	256136	-3225	0	-50384

Notes: N=113. Inconsistent responses are excluded. Confidence levels are used as weights for the weighted estimates.

Discussion and interpretation

Reliability and limitations

The large variation in responses, the sensitivity to exclusion criteria and the large fraction (more than 50%) of incomplete and inconsistent responses, indicate that the representative agent WTP survey approach with its hypothetical scenario is a difficult tool to estimate the external animal welfare costs. The questions may be too difficult for many respondents.

People might have incorrect beliefs about the animals' living conditions, they might misestimate how animals perceive the world, and they might not be impartial when considering animals (i.e. they are not deciding behind a Rawlsian veil of ignorance (Rawls, 1971)). The survey included questions about people's knowledge of animal farming practices and animal mental capacities, and engagement with animal welfare, but due to the large non-normality of the WTP distribution, much larger sample sizes are needed for regression analyses that control for people's beliefs and attitudes about farm animal welfare. The statistical power of the present survey is too low for quantile regressions.

The presence of extreme outliers, the large differences between WTA and WTP, and the sensitivity to exclusion criteria are reasons for concern about the reliability of the results.

Most worrisome is that a large hypothetical bias may be present, as having the experiences of an animal is epistemically transformative, which means that one cannot know how it feels like to be an animal without having to undertake the transformation and really be the animal (Paul, 2014). Such a transformative experience could change one's preferences and hence one's WTP to avoid those experiences.

Respondents may also incorrectly interpret the hypothetical scenario with the choice of colored pills. For example, they might believe that the sleep lasts only one night, which means one will not experience the full life of an animal, but mostly a few hours.

Comparison with existing literature

According to a survey by Espinosa & Treich (2021), about 5% of students agree with the statement that the life of a broiler chicken on a conventional farm is worth living. This corresponds with the observed 9% negative relative WTA and WTP responses in the present survey (Table 1). With better living conditions for the chickens, students in the survey by

Espinosa & Treich (2021) are more optimistic: depending on the scenario (the welfare improvements), 25% to 93% of respondents believe that those chickens have lives worth living. Correspondingly, the present survey shows around 20% to 35% of respondents giving a negative WTP or WTA for a ‘better life’ chicken.

Kuruc & McFadden (2020) offered different estimates of the external animal welfare costs of meat, by assuming specific utility functions for humans and animals. First, in one scenario, the utility functions of humans are assumed to have an equal and constant relative risk aversion parameter $\eta=1.45$, with zero utility at the absolute extreme poverty threshold of \$1.9 per day. Second, the utilities of farm animals are assumed to be equal and equal to the human utility at \$1 per day, i.e. below the extreme poverty line. That means farm animals experience negative utilities (lives not worth living). This negative utility of a farm animal can be equated with a utility decrease from a decrease of daily income for an average US citizen. With these assumptions, the loss of income, measured in \$/day, corresponds with the external animal welfare cost for one animal day, i.e. the loss of welfare for the animal for one day on the farm. Taking into account the average number of days for a chicken, pig or cow to produce one kilogram of meat, the external animal welfare costs are 4400 \$/kg, 450 \$/kg and 760 \$/kg for respectively chicken meat, pork and beef.¹³ These values for pork and beef have the same order of magnitude as the mean relative WTA estimates of the survey (Table 3). Note that with the assumptions of Kuruc & McFadden (2020), the external welfare cost for beef is higher than for pork, whereas the survey estimates in Table 3 show a higher welfare cost for pork.

In contrast with one study estimating the external animal welfare costs of meat (Kuruc & McFadden, 2020), there are several estimates in the literature for the consumer marginal WTP

¹³ Assuming 0.27 kg protein per kg meat and resp. 16250, 2800 and 1650 dollar animal welfare costs per kg protein for chicken meat, pork and beef.

for animal welfare (see references in e.g. Lagerkvist & Hess, 2011 and Lusk & Norwood, 2011). Some estimates (results for the Netherlands): €2.9 - €5.9 per kg extra WTP for pig meat if all the worries about the pig farming sector would be solved (Meuwissen, Van Der Lans & Huirne, 2007), €1.1 - €4.6 per kg extra WTP for extra pig welfare of organic farming (Van Drunen, van Beukering & Aiking, 2010) and €3 per kg extra WTP for animal welfare certified meat (Nocella, Hubbard & Scarpa, 2010). These estimates are in line with (have the same order of magnitude as) the estimates of Table 4.

The WTA-WTP and mean-median gaps

Table 2 shows large differences between the means and the medians and between WTA and WTP. The fact that the means are much larger than the medians can be easily explained by the skewness of the WTP and WTA distributions. These distributions show a small number of extreme values that have a strong outward shifting effect on the means.

The WTA is much higher than the WTP, which is consistent with the literature on the WTA-WTP gap. Several explanations for this gap are discussed in the literature.

- The income effect (Grutters e.a. 2008): as people have a finite amount of money, their WTP to avoid something cannot be arbitrarily large. In contrast, the WTA does not have an upper boundary, so WTA values can become higher than WTP values.
- Loss aversion or endowment effect (Kahneman, Knetsch & Thaler, 1990; Morewedge & Giblin, 2015): as people do not actually experience the suffering of farmed animals as animals themselves, in our hypothetical scenario with the colored pills they consider taking the blue pill (i.e. the situation where they do not have to experience animal suffering) as the reference situation. The choice of reference situation affects

the WTA and WTP. The reference option to avoid experiencing the life of an animal is considered free and costless, as if people believe they own the right to avoid experiencing animal suffering. The WTA-framing is consistent with this right ownership, because people do not have to pay anything to avoid experiencing animal suffering. In contrast, people lose this right in the WTP-framing, because they have to pay for the blue pill that avoids the experiences of animal suffering. With loss aversion, the WTP is lower than the WTA.

- Hypothetical bias (Guzman & Kolstad, 2007): it is shown that the WTA-WTP gap is larger in more hypothetical scenarios and if people have less information about the options. Our colored pill scenario is highly hypothetical, and people lack knowledge about how it really feels to live the whole life of an animal.

The large differences between WTA and WTP and between mean and median poses a problem for the social planner who wants to maximize the non-anthropocentric social welfare function. Which measure for the animal welfare costs should the social planner use? If the social planner assigns to all individuals (humans and animals) the free, costless right not to experience a life full of suffering, the WTA-framing is more appropriate. As mentioned above, this framing is compatible with the free, costless reference option to avoid experiencing the life of an animal. Furthermore, in contrast with the WTP being susceptible to an income effect, the WTA is not susceptible to an upper bound on income, which means the WTA-framing is more appropriate when people have very strong preferences for avoiding experiencing the lives of farm animals.

To avoid the influence of outlier values in highly skewed distributions, the median offers a more robust estimate for a distribution's central tendency than the mean. Therefore, the social planner may prefer the median WTA estimation for the external animal welfare costs of

meat.¹⁴ A further consideration in favor of the median WTA estimate: according to meta-analyses of the hypothetical bias (Little & Barrens, 2004; Murphy e.a. 2005), the mean WTP in hypothetical stated preference or contingent valuation surveys is about three to five times larger than the mean WTP in real choice situations with actual payments. Looking at Table 3, we see that the mean absolute WTP is about six times larger than the median absolute WTA. Hence, the median absolute WTA could be a good estimate of the real mean absolute WTP.¹⁵

The relative versus absolute WTP

The absolute WTP measures the respondent's preference for not experiencing the life of an animal. However, this not only captures the animal welfare costs, because the respondent may also have a preference for not experiencing the life of a neutral welfare animal. The external animal welfare costs are therefore better estimated using the relative WTP, by subtracting the neutral animal WTP (i.e. the WTP to avoid the life of a neutral welfare animal).

We can also give another interpretation of the WTP to avoid the life of a neutral welfare animal, namely as a critical level in the social welfare function (see e.g. Blackorby & Donaldson, 1992; 1995). This critical level is the (positive) reference utility of an animal,

¹⁴ The choice for the median or the mean depends on the measurement cost function (error function, loss function) chosen by the social planner (Wald, 1950; Klebanov, Rachev & Fabozzi, 2009). This cost function measures the cost of a measurement error, i.e. how bad an under- or overestimation of the WTA is according to the social planner. The social welfare function is a natural candidate to construct the measurement cost function. The social welfare function contains the WTA as a parameter. If the parameter changes, the optimum outcome and hence the maximum of the social welfare function changes. With measurement error, the estimated WTA^e differs from the true WTA^t . The social planner could decide to use the difference between the true maximized social welfare W^t (using the true WTA^t) and the estimated maximized social welfare W^e as the measurement cost function. To second order approximation, in the close neighborhood of the maximum social welfare, the difference between W^t and W^e , and hence the measurement cost, is proportional to the square of $WTA^t - WTA^e$. With this measurement cost function, the mean of the WTA is the best estimate. However, the social planner could also decide to take for example the square root of $W^t - W^e$ as the cost function, which is to second order approximation proportional to $|WTA^t - WTA^e|$, i.e. the absolute value of the measurement error. In this case, the median is the best estimate. For large measurement errors, as is likely the case in the present survey, a more complicated measurement cost function is more appropriate, such that neither the mean nor the median are good estimates of the central tendency.

¹⁵ Due to taking the differences between evaluations, this observation is no longer the case for the relative WTP and WTA. The median relative WTA is in fact larger than the mean relative WTP.

above which the life of the animal positively contributes to the social welfare. It is the threshold above which it is socially valuable to have an additional animal brought to the world.¹⁶

The social welfare function becomes the critical-level utilitarian function

$$W = \sum_{h=1}^{N_H} (U_h - C_h) + \sum_{a=1}^{N_A} \delta_a (U_a - C_a),$$

with C_h and C_a the (positive) critical levels for a human and an animal respectively. A social planner can choose positive critical levels in order to avoid the Repugnant Conclusion (Parfit, 1984). If this social welfare function is chosen, the representative agent's utility satisfies:

$$U_H(C_H) + U_A - C_A = U_H(C_H - WTP_H^A),$$

in which WTP_H^A is the absolute WTP. The absolute WTP does not measure U_A , i.e. the animal's utility, but $U_A - C_A$, i.e. the animal's contribution to the social welfare. This contribution, if negative, can be interpreted as the external cost of the existence of the animal, and is larger than the external cost of the suffering of the animal. A neutral welfare animal has a utility $U_A = 0$ but a negative contribution $-C_A$ to the social welfare function.

Comparison with the consumer marginal WTP for animal welfare

Looking at the consumer marginal WTP for animal welfare (Table 4), there are no large differences between types of animal meats: the MWTPs are roughly the same for chicken, pig and cow meat, regardless of the amount of suffering involved with the production of one

¹⁶ It should not be confused with e.g. the threshold above which an individual would agree to live this life.

kilogram of meat. This observation can be considered as an example of scope insensitivity (see e.g. Desvignes e.a. 1992; Kahneman, Ritov & Schkade, 1999).¹⁷

This is in contrast with the large differences for the external animal welfare cost estimations based on the WTP and WTA in Table 3. When evaluating the animal suffering for a kilogram of meat, consumers do not pay much attention to the fact that some animals produce more meat than others. Instead, consumers may be influenced by the degree of affection they feel for the animal. The consumer marginal WTP for the welfare of cows is slightly higher than for pigs, which is again slightly higher than for chickens. These differences could indicate that consumers may be more concerned about the welfare of cows than the welfare of chickens. In other words: the consumer's marginal WTP for animal welfare is not aligned with the estimated external welfare costs of animal suffering. This means that consumers are more concerned about cow welfare than about chicken welfare, and as a consequence may shift their meat consumption from beef towards chicken meat. This shift, based on animal welfare concerns, could increase the real, external animal welfare costs.

Comparison with the monetized consumer utility of meat consumption

The monetized consumer utility of meat can be measured as the average WTP for the consumption of meat. A simplified, back-of-the-envelope calculation of this WTP, is calculating the average height of the consumer demand curve. At a market price of 9 euro/kg for an average meat product and a price-elasticity of meat demand of -0.7 (Andreyeva, Long & Brownell, 2010), assuming a linear demand curve gives us an AWTP of 16 euro/kg. Lusk & Norwood (2009) offer a better estimation, based on the money metric utility or

¹⁷ Note that the representative agent WTP and WTA estimates of the external animal welfare costs can also show a scope insensitivity. If pigs and chickens feel the same daily experiences of suffering on the farm, pigs experience four times more suffering in total duration, as they live four times longer on the farm. But the WTP (and WTA) for chickens and pigs did not show statistically significant differences.

compensating variation: assuming the prices of all other products stay the same, how much does the price of meat have to increase to the point where the consumer is no longer willing to buy meat? With this price increase, it is calculated that an average consumer in the US has to be compensated with \$40 in order to give up 1 kg of meat. In other words, when all other prices stay the same, an average consumer is indifferent between eating 1 kg of meat on the one hand and not eating that meat but receiving \$40 on the other hand.

The above estimates of 16 euro/kg and 40 dollar/kg represent the monetized utility of meat consumption, i.e. the increase in utility from the consumption of an amount of meat expressed in monetary terms. But a consumer can also gain utility from the consumption of vegan meat alternatives (plant-based meats). Suppose that high quality plant-based meat products are on the market at the same price of animal-based meat, such that consumers are indifferent between the animal-based and the plant-based meat products. In that case, consumers do not gain extra utility from the consumption of animal-based instead of plant-based meat. The above estimated monetized utilities do not properly capture the utility of plant-based meat consumption (e.g. Lusk & Norwood (2009) use a model that includes eight other food products next to meat, but those eight products do not capture the whole variety of new plant-based meats).

The estimated monetized utilities of meat are an upper bound on the monetized utility gains from meat consumption (relative to vegan food consumption). These monetized utility gains are the benefits to the consumers, and have to be compared with the welfare costs for the farm animals. For the relative mean WTA estimates, the case is clear: the external animal welfare cost estimates of a kilogram of meat, given in Table 3, are much higher than the monetized consumer utilities of meat. That means the non-anthropocentric social welfare function decreases when humans start to raise and eat animals. If new vegan products enter the market such that the consumer preference for those vegan meat alternatives moves close to the

consumer preference for animal-based meat, the monetized consumer utilities for animal-based meat decrease. In this case, the social welfare function is also more likely to decrease when the median WTA or mean WTP estimates are used.

Meat taxation and the trade-off with climate impacts

As beef production has a higher environmental and climate impact than pork and chicken meat, an environmental taxation (carbon tax) increases the price of beef more than the prices of pork and chicken meat (Table 6). As a consequence, a carbon tax on meat could shift consumption from beef to chicken meat, and this could increase the external animal welfare costs. The shift from beef to chicken and pork depends on the cross price elasticity, which is estimated to be around 0,3 (Lusk en Tonsor, 2016), although some estimates give a zero or even negative cross price elasticity (Fiala, 2006), meaning that (ground) beef and chicken meat are complementary goods instead of substitutes. A cross price elasticity of 0.3 means that a 1% increase in beef prices results in a 0.3% increase in consumption of chicken meat and pork.

Table 6: External climate and environmental (nutrient) pollution costs of meat products

	De Bruyn, Warringa & Odegard (2018)			Errickson, Kuruc & McFadden, (2021)	Funke e.a. (2021)	
	Price in supermarket, the Netherlands (€/kg)	Climate impact costs (€/kg)	Environmental pollution costs (€/kg)	Climate impact costs (\$/kg)	Climate impact costs (\$/kg)	Environmental pollution costs (\$/kg)
Chicken meat	7	0.6	1.1	0.9	0.5	3.4
Pig meat	8	1.1	2.8	1.4	0.6	1.3
Beef	12	1.3	2.7	6.9	5.8	1.0

Table 7 shows a simplified calculation of the changes in demand of meat products and the associated changes in external animal welfare costs, based on the median relative WTA of Table 4, due to a carbon tax. The calculation assumes a partial equilibrium model for meat products, linear demand functions, US arc elasticities for beef, pork and chicken meat (middle income estimates by Lusk & Tonsor, 2016) and average meat consumption levels in the US.

The external climate cost of an average meat consumer is 266 \$/year. Internalizing these costs in the price of meat through a carbon tax increases the external animal welfare costs with 32 \$/year.

Table 7: Calculation of animal welfare cost increase due to a carbon tax on meat

	Chicken meat	Pork	Beef	Total
Retail price US (\$/kg) (USDA Economic Research Service, Meat Price Spreads, 2021)	8	9	15	
% price increase due to carbon tax (average of Errickson e.a. 2021 and Funke e.a. 2021)	0.1	0.125	0.5	
Climate costs (\$/kg)	0.8	1.125	7.5	
Animal welfare costs (\$/kg)	10	0.21	0.008	
Own price elasticity (Lusk & Tonsor, 2016)	-0.67	-0.71	-0.74	
Initial consumption level, without carbon tax (kg/cap/year) (USDA, 2021)	45	23	27	95
Final consumption level, with carbon tax (kg/year)	49	26	19	93
Initial climate costs, without carbon tax (\$/year)	36	26	204	266
Final climate costs, with carbon tax (\$/year)	39	29	140	208
Initial animal welfare costs, without carbon tax (\$/year)	454	5	0.2	459
Final animal welfare costs, with carbon tax (\$/year)	486	5	0.1	491
Animal welfare cost increase due to carbon tax (\$/year)	32	1	-0.07	32
Initial total external costs, without carbon tax (\$/year)	490	30	205	725
Final total external costs, with carbon tax (\$/year)	525	34	140	699
Total external cost difference (\$/year)	34	4	-64	-26

Using the median relative WTA estimates, the total external costs decrease with 26 \$/year when a carbon tax on meat is introduced. However, using the much higher mean relative WTA estimates, the total external costs would increase with 150000 \$/year. Hence, when animal welfare costs are included, a carbon tax on meat could possibly backfire by increasing the total external costs and reducing the non-anthropocentric social welfare function. The animal welfare costs could easily offset the benefit of a carbon tax. Meat consumption is a prime example of how an incomplete internalization of external costs (e.g. only internalizing climate costs) could be counterproductive by increasing the total external costs. To avoid these extra animal welfare costs, a carbon tax can be implemented as a flat meat tax, where all meat products (chicken, pork and beef) have the same absolute price increases per kilogram (e.g. all 7 \$/kg).

Conclusion

The external animal welfare costs of meat production are extremely difficult to measure. One approach, used in this research, is asking people for their willingness to pay (WTP) to avoid the experiences of animals in hypothetical scenarios. Rather than measuring the true or objective external animal welfare costs, the survey questions measure expectations by humans. Although responses can be biased in all kinds of ways and may in particular face a strong hypothetical bias, the results offer some important insights. Most participants' answers to the hypothetical survey question are consistent with the hypothesis that farm animals have lives not worth living (meaning a positive WTP to avoid experiencing the life of a farm animal). The survey results show that the willingness to accept (WTA) is much larger than the WTP, consistent with strong income and loss aversion (endowment) effects. The mean

estimates are much larger than the median, which means that the distributions are very skewed, with extreme outliers.

Due to the strong hypothetical bias and the large non-normality of the data, the survey method is not a reliable tool to make accurate quantitative estimates of the external animal welfare costs. Nevertheless, it offers insights in the signs and the orders of magnitude. The external animal welfare cost of chicken meat is estimated to be around 10 euro/kg, according to the very conservative median WTA estimate, but could be as high as 50000 euro/kg according to the mean WTA estimate. The latter is several orders of magnitude larger than the consumer utility (in monetary terms) of meat consumption, implying that the overall costs exceed the overall benefits of chicken meat consumption. For pork and beef, the benefit-cost ratio is less clear and depends on the chosen measure of animal welfare costs. When the mean WTA is used, pork and beef have external costs higher than 100 euro/kg, which is still an order of magnitude higher than the consumer utility of pork and beef consumption. The mean WTA external animal welfare cost estimates are also two or more orders of magnitude larger than the consumer marginal willingness-to-pay for meat with higher animal welfare standards and the external climate/environmental costs of meat.

The external animal welfare costs of chicken meat is more than two orders of magnitude larger than beef. This means that a demand shift from beef to chicken meat due to misaligned consumer concerns for animal welfare or a carbon tax on meat, could increase external animal welfare costs to such a degree that the non-anthropocentric social welfare function decreases.

Consumers who care about animal welfare are advised to prioritize reducing or eliminating their consumption of chicken meat. And when implementing a carbon tax on meat to internalize the climate costs, policymakers are advised to apply a flat tax on all meat products,

i.e. the same rate for both chicken meat, pork and beef.¹⁸ This flat tax avoids a demand shift from beef and pork to chicken meat that increases the external animal welfare costs.

Conflicts of interest statement

The author declares no financial conflicts of interest.

References

- Andreyeva, T., Long, M. W., & Brownell, K. D. (2010). The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. *American Journal of Public Health*, 100(2), 216-222.
- Blackorby, C., & Donaldson, D. (1992). Pigs and guinea pigs: a note on the ethics of animal exploitation. *The Economic Journal*, 102(415), 1345-1369.
- Blackorby, C., Bossert, W., and Donaldson, D. (1995). Intertemporal Population Ethics: Critical Level Utilitarian Principles, *Econometrica* 65, 1303-1320.
- Carrier, A., & Treich, N. (2020). Directly valuing animal welfare in (environmental) economics. *International Review of Environmental and Resource Economics*, 14(1), 113-152.
- De Bruyn, S., Warringa G. & Odegard, I. (2018). *De echte prijs van vlees*. CE Delft, The Netherlands, Delft

¹⁸ A cap-and-trade system could be preferred over a tax on meat. A meat tax result in less control under moderate-to-high inflation scenarios. With a cap-and-trade system, specific caps could be set by type of meat product, to avoid a demand shift towards chicken meat.

- Desvougues, W., Johnson, R., Dunford, R., Boyle, K., Hudson, S. & Wilson, N. (1992). Measuring Non-Use Damages Using Contingent Valuation: An Experimental Evaluation of Accuracy. *Research Triangle Institute Monograph*. 92–1.
- Errickson, F., Kuruc, K., & McFadden, J. (2021). Animal-based foods have high social and climate costs. *Nature Food*, 2(4), 274-281.
- Espinosa, R., & Treich, N. (2021). Animal welfare: Antispeciesism, veganism and a “life worth living”. *Social Choice and Welfare*, 56(3), 531-548.
- Espinosa, R. (2022). *Animals and Social Welfare*. Available at dx.doi.org/10.2139/ssrn.4113271.
- Fearing, J., & Matheny, G. (2007). The role of economics in achieving welfare gains for animals. In D.J. Salem & A.N. Rowan (Eds.), *The state of the animals 2007* (pp. 159-173). Washington, DC: Humane Society Press.
- Fiala, N. (2006). Estimates of US within Product Demand Elasticities for Meat. *Economic Research Service and United States Department of Agriculture, Washington, DC, USA*.
- Funke, F., Mattauch, L., van den Bijgaart, I., Godfray, C., Hepburn, C. J., Klenert, D., Springmann, M. & Treich, N. (2021). Is meat too cheap? Towards optimal meat taxation. *INET Oxford Working Paper No. 2021-08*.
- Greaves, H. (2017). Population axiology. *Philosophy Compass*, 12(11), e12442.
- Grutters, J. P., Kessels, A. G., Dirksen, C. D., Van Helvoort-Postulart, D., Anteunis, L. J., & Joore, M. A. (2008). Willingness to accept versus willingness to pay in a discrete choice experiment. *Value in Health*, 11(7), 1110-1119.
- Guzman, R. M., & Kolstad, C. D. (2007). Researching preferences, valuation and hypothetical bias. *Environmental and Resource Economics*, 37(3), 465-487.

- Johansson-Stenman, O. (2018). Animal welfare and social decisions: Is it time to take Bentham seriously?. *Ecological Economics*, 145, 90-103.
- Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental tests of the endowment effect and the Coase theorem. *Journal of Political Economy*, 98(6), 1325-1348.
- Kahneman, D., Ritov, I., Schkade, D., Sherman, S. J., & Varian, H. R. (1999). Economic preferences or attitude expressions? An analysis of dollar responses to public issues. In *Elicitation of preferences* (pp. 203-242). Springer, Dordrecht.
- Klebanov, L. B., Rachev, S. T., & Fabozzi, F. J. (2009). Robust and non-robust models in statistics (p. 317). Hauppauge: Nova Science Publishers.
- Kuruc, K., & McFadden, J. (2020). *Optimal Animal Agriculture Under Climate and Population Externalities*. Selected Paper prepared for presentation at the 2020 Agricultural & Applied Economics Association Annual Meeting, Kansas City.
- Lagerkvist, C. J., & Hess, S. (2011). A meta-analysis of consumer willingness to pay for farm animal welfare. *European Review of Agricultural Economics*, 38(1), 55-78.
- Little, J. & Berrens, R. (2004). Explaining Disparities between Actual and Hypothetical Stated Values: Further Investigation Using Meta-Analysis. *Economics Bulletin*, 3(6), 1-13.
- Lusk, J. L., & Tonsor, G. T. (2016). How meat demand elasticities vary with price, income, and product category. *Applied Economic Perspectives and Policy*, 38(4), 673-711.
- Lusk, J. L., & Norwood, F. B. (2009). Some economic benefits and costs of vegetarianism. *Agricultural and Resource Economics Review*, 38(2), 109-124.
- Lusk, J. L., & Norwood, F. B. (2011). Animal welfare economics. *Applied Economic Perspectives and Policy*, 33(4), 463-483.

- Lusk, J. L., & Norwood, F. B. (2012). Speciesism, altruism and the economics of animal welfare. *European Review of Agricultural Economics*, 39(2), 189-212.
- Matheny, G., & Chan, K. M. (2005). Human diets and animal welfare: The illogic of the larder. *Journal of Agricultural and Environmental Ethics*, 18(6), 579-594.
- Meuwissen, M.P.M., Van Der Lans, I.A. & Huirne, R.B.M. (2007). Consumer preferences for pork supply chain attributes, *NJAS - Wageningen Journal of Life Sciences*, 54(3): 293-312.
- Morewedge, C. K., & Giblin, C. E. (2015). Explanations of the endowment effect: an integrative review. *Trends in Cognitive Sciences*, 19(6), 339-348.
- Morrison, M., & Brown, T. C. (2009). Testing the effectiveness of certainty scales, cheap talk, and dissonance-minimization in reducing hypothetical bias in contingent valuation studies. *Environmental and Resource Economics*, 44(3), 307-326.
- Murphy J.J., Allen, P.G., Stevens, T.H., Weatherhead, D. (2005). A meta-analysis of hypothetical bias in stated preference valuation. *Environ Resource Econ* 30, 313–325
- Nocella, G., Hubbard, L. & Scarpa, R. (2010). Farm Animal Welfare, Consumer Willingness to Pay, and Trust: Results of a Cross-National Survey, *Applied Economic Perspectives and Policy*, pp. 1–23.
- Parfit, D. (1984). *Reasons and Persons*, Oxford: Clarendon Press.
- Paul, L.A. 2014. *Transformative Experience*. Oxford, UK: Oxford University Press.
- Singer, P. (2002). *Animal Liberation*. New York: HarperCollins.
- Rawls, J. (1971). *A Theory of Justice*. Cambridge Mass.: Belknap Press of Harvard University Press.

Ready, R. C., Champ, P. A., & Lawton, J. L. (2010). Using respondent uncertainty to mitigate hypothetical bias in a stated choice experiment. *Land Economics*, 86(2), 363-381.

Van Drunen, M., van Beukering, P. & Aiking, H. (2010). *De echte prijs van vlees*. Instituut voor Milieuvraagstukken, Vrije Universiteit Amsterdam.

Wald, A. (1950). *Statistical Decision Functions*. Wiley.