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Featured Article

Animal Welfare Economics

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Abstract *This article highlights some key areas where economics can contribute to the current debate about animal welfare. Production economics reveals that producers will not maximize animal welfare, even if animal well-being is highly correlated with output. Welfare economics raises thorny issues about the double-counting of benefits when humans exhibit altruism towards animals, while public economics uncovers potential market failures and possible solutions. Consumer economics provides a means of determining human and animal benefits from animal well-being policies in dollar terms. Overall, economists have much to contribute to the animal welfare debate and the well-being of humans and animals could be improved with more economic analysis on the effects of private and government actions related to animal welfare.*

Key words: animal welfare, animal rights, livestock, utilitarianism.
JEL Codes: Q18, Q13, D60.

Introduction

Whereas concern about the treatment of farm animals was once a fringe debate among activists, it is now a central concern of both livestock and poultry producers. Indeed, from the small but growing success of niche markets for free range eggs and meat to the passage of legislation and ballot initiatives banning certain animal housing practices, animal welfare is now at the forefront of discussions about the future of animal agriculture. Leading the debates have been animal rights activists, philosophers, and lawyers (for example, Harrison 1964; Regan 2004; Singer 1975, 2002; Sunstein and Nussbaum 2005). Biologists and animal scientists have also been proactive in studying issues related to animal welfare (for example, Appleby and Hughes 1997; Broom and Johnson 1993; Dawkins 1980).

Economists have arrived relatively late to the scene. Until perhaps ten years ago, economists' contributions to the animal welfare debate could probably be counted on two hands. In response to policy initiatives related to the use of battery cages in the U.K., about 15 years ago Richard

Bennett and colleagues began studying consumer preferences for hen laying practices (Bennett 1995, 1997; Bennett and Larson 1996). Around the same time, McInerney (1993) presented a talk outlining his views on how to study farm animal welfare in an economic framework. Later, Cowen (2006) and others highlighted some of the market failures that might arise in relation to animal welfare. Since that time, economic work on the issue of farm animal welfare has grown rapidly, but has primarily focused on issues related to consumer preferences. Because the economics of animal welfare is a relatively nascent area of inquiry, and one likely to become more important in the future, the key purpose of this article is to ask what economics has to offer when addressing some of the existing animal welfare controversies. That is, what does the discipline of economics bring to the table, and how can economists meaningfully contribute to ongoing debates? In such a short space we cannot possibly provide a comprehensive assessment of the economics of farm animal welfare, but do hope to provide an overview of the debate and highlight some areas in need of additional economic research. Interested readers are directed to our more comprehensive work in Norwood and Lusk (2011a).

In what follows, we highlight some areas where economic insights and research can help improve our understanding of the consequences of farm animal welfare policies. In the next section we discuss issues related to production economics, and then move to issues related to welfare economics. Next, we discuss market failures and some potential mechanisms that might be used to help solve them. Lastly, we survey some of the consumer research on animal welfare and speculate how these methods might also be used to study animal preferences. The final section concludes.

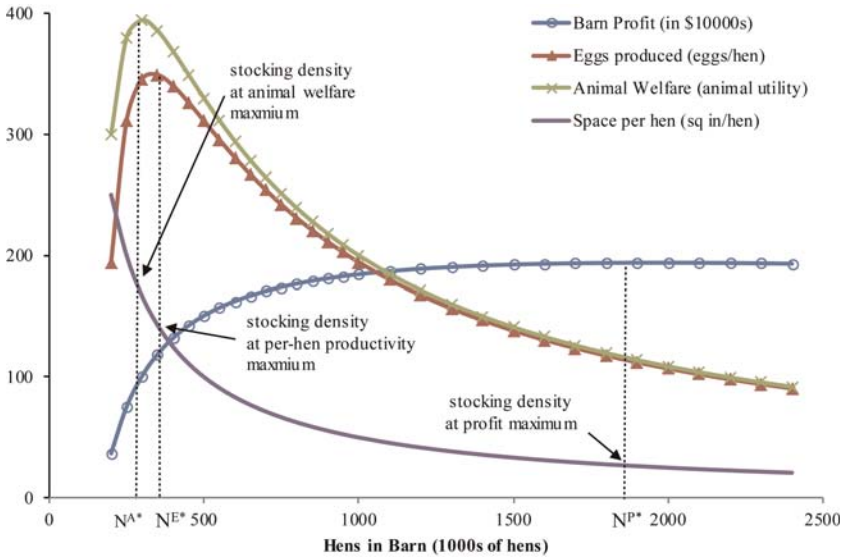
Production Economics

Those involved in commercial agriculture often assert that profitability and animal welfare go hand-in-hand. Common arguments that may be heard from producers are: "I can't make money if my animals aren't well cared for," or "Profitable animals are happy animals." The underlying logic is that farm animals which receive better care will be more productive, and as a result will be more profitable. Animal science professor Stanley Curtis (2007) summarized the view well, arguing that animal performance (both productivity and reproductive performance) is the best measure and indicator of farm animal well-being. It seems, then, that the profit incentive is perfectly aligned with the incentive to maximize animal welfare. Or is it?

Students of production economics are taught early on that the level of input usage that maximizes production or yield is not the same as the level of input usage which maximizes profits. When inputs are costly, a profit-maximizing farmer will choose to produce less than is biologically possible. Similar reasoning suggests that a profit-maximizing livestock, egg, or poultry producer will choose levels of production that do not coincide with biologically optimal levels of animal production or animal welfare. In the case of stocking density, which is one of the more controversial issues in the animal welfare arena, a producer has a profit incentive to stock animals more densely than any individual animal would prefer.

It may seem strange to talk about animal preferences for stocking density, but animals clearly have preferences. If animals can choose

Figure 1. Relationship between animal welfare, egg production, and profitability for a producer constrained by barn space



one outcome over another, the choice reveals an underlying preference. Experiments of just this sort have been carried out by animal scientists and the results reveal, for example, that hens prefer outdoor access to cages and hogs prefer social contact to isolation (Dawkins 1977; Kirkden and Pajor 2006; Matthews and Ladewig 1994). Moreover, recall the arguments of the agricultural producers – that profitable animals are happy animals. Is this not an implicit recognition of animal preferences? If an animal can be "happy" it must prefer some outcomes to others.

It is instructive to consider the trade-off between animal well-being, productivity, and profitability using a simple example. Imagine an egg producer facing the short-run problem of deciding how many hens to stock in a barn with a fixed amount of space. Suppose the animal scientists' arguments are correct and each hen tends to produce more eggs when they are happier and fewer eggs when sadder. If hens are too densely stocked—for example, so tightly caged that they cannot move or turn around—they will clearly be unhappy and unproductive. Thus, providing a bit more space per hen will increase both welfare and output. At some point, however, too much space is undesirable from both a production and a welfare standpoint. A single isolated hen is likely to be lonely (visitors to egg farms will notice that hens often prefer to flock in groups even in a free-range environment), and as chickens expend energy roaming about, they will be less productive compared to hens more tightly confined. Of course, productivity and welfare are not perfectly aligned and it is probably true that hens would prefer more space than would maximize their individual egg output.

Figure 1 illustrates this situation using a hypothetical (but plausible) example of a producer deciding how many hens to stock in a barn of a fixed size. The top two curves illustrate the inverse U-shaped relationship between animal welfare and stocking density and between per-hen egg

production and stocking density.[1] The top curve shows that each hen is happiest when there are approximately $N^{A*} = 298{,}000$ hens in the barn, providing about 170 square inches of space per hen.[2] That is, animal welfare is maximized when each bird has 170 square inches of space. By contrast, the other inverse U-shaped curve shows that egg production is maximized at 350 eggs/hen/year when there are about $N^{E*} = 333{,}000$ hens in the barn, providing about 150 square inches per hen.

The curves are drawn to reflect the aforementioned situation where productivity and welfare are highly related, as suggested by animal scientists (in fact, the correlation coefficient between the two curves drawn in figure 1 is 0.99), but where hens prefer slightly more space (170 square inches) than is needed to maximize per-hen egg production (150 square inches).

If a producer were interested in maximizing per-hen productivity, figure 1 shows that they would stock a few thousand more hens in the barn (allowing per-hen space to fall from 170 to 150 sq inches), and only a small amount of welfare would be sacrificed to achieve the maximum biological level of egg production. Producers, however, are typically not interested in maximizing per-hen egg productivity. Rather, they are interested in maximizing the total amount of profit that can be achieved from the fixed barn space. That is, producers are not paid based on the number of eggs produced *per hen*, but rather on the *total* number of eggs coming out of the barn. As a result, a profit-maximizing producer will choose to sacrifice some individual hen performance if they can put more egg-producing hens in the barn. Figure 1 is drawn to illustrate exactly this situation.

In our example, the profit-maximizing number of hens to place in the barn is given by $N^{P*} = 1.97$ million hens; this stocking density provides less than 50 square inches per hen. At this high stocking density, there are many more birds and each is much more crowded than when per-hen egg production is maximized. As a result, figure 1 shows that at the profit-maximizing stocking density, each hen only produces about 108 eggs/year – many fewer than the biological potential of 350 eggs/hen/year. Despite this loss in per hen productivity, there are many more hens in the barn when profits are maximized as compared to when per-hen egg productivity is maximized (almost 2 million hens vs. 0.3 million hens). When per-hen egg productivity is maximized, there are 333,000 hens, each producing 350 eggs for a total production equal to 116.5 million eggs/barn/year. When barn profit is maximized, there are 1.97 million hens, each producing 108 eggs for total production equal to 212.8 million eggs/barn/year. Thus, the choice for the producer is fewer happy hens producing a total of 116.5 million eggs/year, or many more relatively sad hens producing a total of 212.8 million eggs/year. In this example, the producer

[1]*The figure is drawn assuming the number of eggs produced per hen per year,* E, *is given by* $E = \alpha S + \beta S^2$, *where* S *is space per hen in square inches. Animal welfare,* W, *is similarly given by the function* $W = \gamma S + \delta S^2$. *The producer is assumed to choose the number of hens in the barn,* N, *to maximize profit,* π, *which is equal to* $\pi = P_E NE - P_H N$ *subject to the constraint* $NS \leq T$, *where* P_E *is the price of an egg,* P_H *is the per hen production cost (which may depend on the stocking density, an issue we assumed to be of minor significance for the present example), and* T *is the total space in the barn in square inches. The figure is drawn under the following parameterization* $\alpha = 4.667$, $\beta = -0.01556$, $\gamma = 4.7$, $\delta = -0.014$, $P_E = 0.1$, $P_H = 1$, *and* $T = 50$ *million.*

[2]*The actual numbers shown in Figure 1 and reported in the text are for illustrative purposes only, and are not meant to represent production relationships on any particular farm.*

will almost double their revenue by lowering animal welfare and more densely stocking their barn.

Figure 1 is of course a simplified depiction of reality and may not perfectly reflect actual production functions. For example, the difference in stocking densities between the profit, productivity, and welfare maximizing cases may not be as great in reality as shown in figure 1. However, this does not negate the fact that a producer faces an incentive to sacrifice some animal well-being for profit when constrained by space. In the longer run, producers can buy more land or build new barns, but space is only one input that a farmer must supply animals. Any time an input is costly – whether it be space, feed, bedding, labor, or medicine – just as in the real world, it is profitable to choose less of the input than any individual animal would prefer. This should not be surprising. As consumers we cannot have everything we want because we face a binding budget constraint; our happiness is not as high as it could be if we were richer. So too is it for animals.

Though many producers care passionately about the well-being of the animals under their care, few would argue that the goal of commercial agriculture is to maximize animal well-being. Nevertheless, many in the agriculture community want to argue that animals are most happy when producers are most profitable. A little economic reasoning shows that this is not the case. In a competitive environment, producers who wish to stay in business face incentives to adopt production systems and practices that maximize profit, and profit-maximizing outcomes are not the same as animal welfare-maximizing outcomes. Thus, the real question of interest is not *whether* profitability must be sacrificed to achieve higher levels of animal welfare, but rather *how much*.

Indeed, the literature on the costs of improved animal welfare is relatively sparse. There are a few budgetary studies that estimate cost increases resulting from the elimination of gestation crates or battery cages (see for example, Sumner et al. 2008). However, much less is known about the how these costs change with the size of the operation. There is much useful work that remains to be done on the economies (or diseconomies) of scale and scope in supplying animal welfare. Moreover, production economics could provide much needed information on the relative risks associated with cage-free systems in which output might be more volatile than in conventional systems. Additional research on the costs of animal welfare is needed to improve cost-benefit analysis, as well as to understand the extent to which rising prices resulting from the higher costs of new animal housing systems will curb consumer purchases of eggs, milk, and meat. Of particular interest is the effect of food price increases on the poor.

Welfare Economics

We begin the discussion on welfare economics with a provocative proposition:

> When determining the benefits of a new regulation, we should only count the benefits that accrue to *men* and ignore the benefits enjoyed by *women*.

Before throwing down this article in disgust, consider a related proposition:

When determining the benefits of a new regulation, we should only count the benefits that accrue to *humans* and ignore the benefits enjoyed by *animals*.

Most people (at least in the practice of cost-benefit analysis) reject the first proposal, but accept the second. Leading philosophers such as Peter Singer at Princeton University, however, suggest that if we reject the first proposition, that women's welfare should be ignored, we have no logical reason for rejecting the second proposition, that animals' welfare be ignored (see Matheny 2006; Singer 2002). To ignore a woman's welfare is to be called a sexist. To ignore an animal's welfare is to be called a speciest – at least by philosophers such as Singer.[3]

Men and women are no doubt different in many respects, but they are similar in their capacity to feel pleasure and pain. Thus, there is no reason to treat pleasure or pain differently simply because it comes from a man or a woman; the "utils" of both sexes should receive equal consideration in the benefit calculation, regardless of their source. Utilitarians such as Singer extend these arguments to animals. If animals can suffer, then their suffering demands equal consideration in the social welfare function that aggregates the suffering (or happiness) of men and women. To ignore animal suffering is to arbitrarily discriminate against two equal sources of utility simply because one comes from an animal.

These views are quite different than those expressed by some economists. McInerney (1993), for example, argued when dealing with the economics of animal welfare that "animals are no more than resources employed in economic processes which generate benefits for people," (p. 4). He went on to argue that any effects felt by animals "are only relevant if they are experienced by people; they have no meaning if attributed to resources," (p. 5). Without necessarily taking a position on this philosophical issue, we believe it is at least prudent to further explore the consequences of extending the traditional economic utilitarian welfare analysis to include animal welfare. An objective researcher cannot reject non-speciest analyses without first exploring their consequences. As we show in what follows, applying some economic reasoning to the topic yields some insights that seem to have been largely overlooked by philosophers, even though in some cases the basic results have been known to environmental economists for some time.

Cost-Benefit Analysis When Animal Benefits Enter the Social Welfare Function

The practical reality is that existing cost-benefit analyses of animal welfare policies are speciest: they only explicitly consider the benefits and costs of the policy to *people*. The primary question we ask in this section is whether such an approach has any justification.

For illustrative purposes, consider a thought experiment associated with Proposition 2 (Prop 2) in California. Prop 2 was a ballot initiative introduced in California in 2008 by animal activist groups such as the Humane Society of the Unites States (HSUS). The initiative sought to ban the use of

[3]*In the literature on the subject the word is sometimes spelled "speciesist" rather than "speciest." As there seems to be no uniformly agreed-upon spelling, we use the shorter spelling. Also, it should be noted that in the forgoing discussion there are many forms of utilitarianism and not all philosophers would necessarily agree with our application of it. Moreover, even though Singer uses utilitarian arguments to advocate for better animal welfare, he also makes other moral arguments that seem unrelated to utilitarian reasoning.*

battery cages in egg production, and it passed with more than 60% of Californians voting in favor. Imagine the thought process involved in conducting an *ex ante* cost-benefit analysis.

Although most Californians do not buy cage-free or organic eggs (see the data in Lusk 2010), this should not be taken to imply that they care for the welfare of laying hens. The situation could simply reflect a classic public-good problem: Californians might value animal welfare improvements, but realize their individual contributions in the form of cage-free egg purchases are too small to have a significant impact, and as a result many free-ride on the cage-free egg purchases of others.

For argument's sake, suppose that the only reason Californians valued a prohibition of cages is out of concern for farm animals (not because they thought the ban would produce better-tasting or safer eggs). That is, suppose Californians are altruistic toward animals. When animals are happier, Californians are happier; when animals are sadder, Californians are sadder. When Prop 2 comes along, Californians are presented with a chance to coordinate their actions and eliminate the free-rider problem.

The passage of Prop 2 will entail costs borne by Californians. Some will pay higher egg prices, some will switch consumption from eggs to less desirable alternatives, and some egg farmers will go out of business. Suppose all these costs amount to $75 million annually.[4] If Prop 2 passes, the costs will be partially offset by the (altruistic) benefit that Californians will receive from their believing that hens are happier without cages.

Suppose Californians believe hens will be better off – in monetary terms – by $100 million annually if Prop 2 passes. Ignore for the moment the question of *how* such benefits to the hens can be quantified, and for arguments sake take it for granted that the animals' benefits can be quantified in a manner similar to the usual quantification of human benefits. Because Californians are altruistic, they are happier when hens are happier; suppose for every $1 hens (as a group) are better off, Californians (as a group) are also better off by $0.25. So if Prop 2 will benefit hens by $100 million, Californians also benefit by $100*0.25 = $25 million annually because they care about the well-being of animals.

Given the situation laid out in the above scenario, how should a Californian committed to non-speciest utilitarianism vote? The answer is clear: add up all the benefits to people and all the benefits to animals and subtract all the costs to people and all the costs to animals. In our case, the benefits to people are $25 million, the benefits to animals are $100 million, and the costs are $75 million. Total benefits are $125 million and total costs are only $75 million; thus, the non-speciest cost-benefit test is passed.

If the policy passes, however, people will pay the costs ($75 million), which are significantly higher than *their* benefits (only $25 million). This might be reason enough for Californians to vote against the policy, but such reasoning would potentially be called speciest because it only focuses on the costs and benefits of *people*.

One criterion that economists are accustomed to using in such situations relies on the work of Kaldor (1939) and Hicks (1939), who reasoned that one almost never encounters Pareto improving situations in which at least some people benefit and no one is made worse off. As a result, one might

[4]*This cost figure is provided simply for illustrative purposes. To see some estimates of the actual costs of the policy, see Sumner et al. (2008).*

use a redistributive test. If the sum of the gains of the winners can be transferred to the losers such that some people are better off and others are no worse off (at least in theory if not in practice), then a policy passes the redistributive test and is deemed desirable by many economists. For many (and perhaps most) of the problems tackled by applied economists conducting cost-benefit analyses, there is no conflict between the efficiency test (Do the benefits exceed the costs?) and the redistributive test (Are the gains of the winners sufficient to offset the losses of the losers?). In conventional situations, a policy which passes the cost-benefit test will also pass the redistributive test. This relationship, however, breaks down when altruism is involved.[5]

Going back to the California example, suppose Prop 2 passes and animals are better off by $100 million, but people are worse off by $25-$75 = -$50 million because their costs exceed their benefits. Can some of the gains from the animals be transferred or redistributed to the humans so they can also be made better off?[6] The answer is no. To illustrate, consider the extreme case where $99 million of the hens' benefits are taken and redistributed to humans. The hens are still better off with the policy because they are left with $1 million. What about humans? Are they not happy receiving the transfer of $99 million? Yes, but remember – humans are altruistic and their welfare moves in tandem (at a rate of 0.25 to 1) with the animals'. When the $99 million was taken from the animals, humans experienced sadness equal to -$99*0.25 = -$24.75 million. So, the net effect on humans is that they pay the cost of $75 million, experience losses of $24.75 million because the transfer made animals sadder, and then benefit by receiving the transfer of $99 million. Thus, the net effect on humans is -$75-$24.75 + $99 = -$0.75 million after the transfer. Humans lose even after the hens redistribute virtually all their benefits. In fact, given the scenario outlined, it is impossible to find a transfer amount that would make both humans and animals better off from the passage of Prop 2.

Armed with this knowledge, how should a Californian vote? The policy passes the non-speciest cost-benefit test, but fails the speciest cost-benefit test. Moreover, the policy fails the redistributive test. Non-speciest utilitarians would likely argue that one should continue to vote in favor of Prop 2; however, the insight provided by economic reasoning is that the inclusion of altruism in the equation complicates the typical logic outlined by animal welfare philosophers. Altruism serves to double-count benefits, preventing redistributive schemes from achieving the Pareto optimal outcome.

In Lusk and Norwood (2011), we argue that if one wishes to evaluate policies consistent with efficiency *and* redistributive tests, then the analyst should: 1) ignore human altruism if one is conducting non-speciest cost-benefit analysis (where the social welfare function includes benefits and costs to animals); 2) include human altruism but conduct speciest cost-benefit analysis (where the social welfare function does *not* include benefits and costs to animals); or 3) conduct cost-benefit analysis on animals in certain cases. In fact, we show that in certain situations, a necessary and

[5]*This general insight has been noted in other contexts by, for example, Bergstrom (2006) and Jones-Lee (1992).*

[6]*It might seem fanciful to imagine transferring a gain from animals, but such a move could be implemented by reducing any costly input that is valued by the animal which also has human uses.*

sufficient condition for a policy to pass the efficiency and redistributive test is that total animal willingness-to-pay for the policy exceeds the total costs of the policy.

Utilitarianism and the Ethics of Raising Farm Animals

Advocates of non-speciest utilitarianism often implicitly assert that by making animal welfare "count", the natural result is a call for stricter animal welfare regulations. However, the case becomes much less clear when one considers 1) differences in animal productivity in different production systems, and 2) the amount of food produced per animal.

Consider, for example, the question of whether it is more ethical (and by ethical we mean produces a higher level of total "utils" in a non-speciest utilitarian analysis) to eat eggs laid by hens in a cage-free production system or eggs laid by hens in a battery cage system. Many animal welfare advocates argue that hens living in battery cage systems suffer, and while many contend that hens in cage-free (that is, barn or aviary) systems are slightly better off, they assert that these hens suffer there too. Under this scenario, it could be ethical for an individual to eschew eggs altogether and become vegan (depending on the person's own welfare loss resulting from an egg-free diet relative to the "gain" from fewer suffering chickens). However, if one is committed to eating a given quantity of eggs, it is quite possible that the ethical thing to do is to eat eggs from the battery cage system. Why? Because it takes fewer hens to produce the same amount of eggs in a battery cage system than it does in a barn system (see the discussion in chapter 7 in Norwood and Lusk 2011a). If hens must suffer to produce eggs, it may be better to have fewer hens suffering more intensely than many hens suffering less intensely. Of course, not everyone agrees that hens suffer in battery cage (or cage-free barn) systems, but the point is that non-speciest utilitarianism does not automatically imply the need for tighter animal welfare regulations. To further illustrate, consider another example.

Many vegetarians assert that meat-eaters are unethical because their consumption decisions cause some unhappy animals to be brought into the world. But is it not true that meat-eaters could also assert that vegetarians are unethical because their consumption decisions fail to bring some happy animals into the world? Utilitarian analysis simply adds up units of happiness and subtracts units of sadness, but the end result is a total aggregate of "utils," and utilitarianism is typically silent about the merits of how the total is achieved. We can potentially achieve the same level of welfare prohibiting sadness (the vegetarian's solution) or by encouraging happiness (the meat-eaters' solution).

Although there are many modern production practices that lead to lower levels of animal welfare than would be the case if they were not used (for example, gestation crates or high stocking densities), it is not at all clear that farm animals, even those on so-called "factory farms", are better off dead than alive. To conclude that the animals are better off dead is to conclude that it is ethically justifiable (from a purely utilitarian standpoint) to kill all existing farm animals rather than have them go on living in current conditions. Few people are willing to go this far. But if one is unwilling to kill an animal rather than have it live in its current conditions, why would

they – from a strictly utilitarian perspective – prevent another identical animal from being born into the same conditions?

Aside from the questionable case of whether, for example, sows in gestation crates live a life that is overall worth living (that is, whether the sow produces more positive "utils" in her life than negative ones), there are many farm animals that arguably live overall good lives. Although there are a few concerns about transportation and slaughter conditions, beef cattle, for example, live a relatively desirable life, especially when given pasture. They are able to exhibit virtually all the natural behaviors they would in the wild and yet, unlike wild animals, are given food and medicine and are protected from predators. An individual who refuses to eat beef is an individual who refuses to contribute to a process which brings arguably happy animals into the world. From a strictly utilitarian perspective, this is as equally unethical as the choice of an individual who continues to eat eggs from a production system in which hens are better off dead than alive.

Another distinction between cows and chickens is that cows produce much more meat per brain than chickens, and because the brain is where the units of "utils" are created (or suffering and sadness are "felt"), one might very well prefer to eat beef over chicken, even if cows suffered more than chickens (assuming both cows and chickens suffer). The reason for this is that aggregate utilitarianism is not interested in suffering *per animal* but in *total* suffering. Better to have fewer brains suffering than many – especially if the fewer brains are producing much more food. Of course, as long as we are adding up "utils", one might want to think about the effects of crop and livestock production on non-farm animals that occupy the land, for example rabbits, snakes, and coyotes.

Despite its philosophical appeal, most people are unwilling to accept the cold logic of utilitarianism when taken to its extremes. Indeed, the kind of logic used above could be used to justify outcomes that conflict with our moral intuitions. For example, total utilitarianism might favor a massive population near the Malthusian limit – with each individual barely eking out a livable existence. Utilitarianism is a useful tool, but is far from clear that most of us would accept it as the ultimate moral authority. For example, many people care about distributional issues in addition to the total size of the pie.

While our above discussion focused on distributional issues of costs and benefits among animals and humans, many are concerned solely about distributional issues among humans. For example, after the passage of Prop 2, there has been much debate about the adverse and potentially regressive effects of rising egg prices on the poor. There are also distributional issues among different types of: producers (large vs. small, current cage-free operators vs. cage operators, domestic vs. foreign); consumers (poor vs. rich, taxpayers vs. non-taxpayers, meat-eaters vs. vegetarians); and animals (dairy cows vs. beef cows, chickens vs. hogs). Many people are concerned about inequalities, either within or across these groups that are ignored in utilitarian analysis.

Nevertheless, most applied economists (whether they recognize it or not) practice a form of utilitarianism in their professional lives. When it is concluded that policy A is preferable to policy B, it is often because we have calculated that the sum of producer and consumer surplus are higher with A than with B. When we say that monopolistic outcomes are

less desirable than competitive ones, it is because we calculate that total welfare is higher in the latter rather than the former case. These conclusions are nothing more than applied utilitarianism. Given our proclivity for utilitarian analysis, economists are well positioned to draw out the sometimes counter-intuitive consequences of policies that are advocated by animal welfare activists.

Practical Issues Associated with Non-Speciest Welfare Analysis

Recognizing that human altruism might imply some challenges for aggregating benefits in a non-speciest welfare function, analysts might wonder whether straightforward ways exist for calculating changes in animal welfare using existing economic models. We believe the answer is yes.

Conventional economic models such as equilibrium displacement models (for example, Alston 1991; Wohlgenant 2011) or general equilibrium models (Hertel 1991) show how the prices and quantities of commodities change as a result of exogenous shocks to the supply/demand system. These price and consumption changes are then used to determine welfare changes to human consumers (that is, consumer surplus) and changes to human producers (that is, producer surplus). In simple equilibrium displacement models, all one needs to know to calculate changes in consumer surplus is: 1) the size of the demand shock; 2) the change in price resulting from the shock; 3) the change in the quantity resulting from the shock; and 4) total expenditures spent on the good in question (see Wohlgenant 2011). One does not need much more information to further infer how animals are affected by a policy.

To illustrate, consider the work of Bracke et al. (2002), who showed how to relate sow well-being to a set of underlying inputs to the production process. These authors' analysis provided a means of calculating an index of sow welfare (scaled to range from between 0 to 10) depending on sow living conditions. In a sense, Bracke et al. (2002) provided an estimate of the production function for sow welfare (in essence, they estimated the equivalent of the inverse U-shaped curve shown in figure 1 relating space to welfare for sows). Analyses such as those by Bracke et al. (2002) allow one to specify a welfare function like $AW = \mathrm{f}(x_1, x_2, \ldots x_n)$, where AW is the scaled index of sow well-being, and x_i is the amount of the i^{th} input provided to the sow. Given such a function, then the change in animal welfare is simply calculated as: $\mathrm{d}AW = (\partial \mathrm{f}/\partial x_1)\mathrm{d}x_1 + \ldots + (\partial \mathrm{f}/\partial x_n)\mathrm{d}x_n$. Here is the key point: the changes in input usage, $\mathrm{d}x_i$, are the values that already come out of traditional economic analysis such as equilibrium displacement models. All one needs to do is couple these estimates with how animal welfare changes as a result of the input change (that is, $\partial \mathrm{f}/\partial x_i$); there exist numerous articles in the animal science and behavior literature that allow one to do this (for a similar model for egg layers, see De Mol et al. 2006; for dairy cattle see Ursinus et al. 2009; Botreau et al. 2007a,b present general discussions on the issue).

Most models in the animal science and behavior literature relate underlying production characteristics (or inputs) to some scaled measure of welfare. This allows an analyst to know whether a policy makes animals better or worse off, but does not allow aggregation with consumer and producer surplus because of differences in units of measurements. To provide an aggregate measure of welfare, one would need to convert units

of animal welfare to units of dollars. As we discuss in a subsequent section, such a conversion is possible in much the same way that we translate units of consumer utility to units of dollars through the calculation of consumer surplus.

Public Economics - Market Failures

Analyzing animal welfare is complicated by it being a good that has characteristics which make it susceptible to a number of inter-related types of market failure. First and foremost is the fact that animal welfare is not priced in any conventional way. So while we know the price of obtaining more eggs or more pork chops, it is relatively difficult to ascertain the price of higher farm animal welfare. Without a price, the market will not necessarily work its magic in efficiently allocating resources to their most valued use.

Even if animal welfare were separately priced in the market, other problems would remain. In particular, consuming animal products generates an externality. My decision to eat pork from a gestation crate system brings sadness to certain people who abhor sows being housed in small cages.[7] Moreover, my decision to eat pork has a huge effect on yet another third party: the pig. After all, the pig must die if I am to have bacon. In such cases, I will eat more pork that would be socially desirable from an aggregate utilitarian analysis because I fail to internalize the costs of my consumption decisions on other people and on animals.

Adding to the problem is that animal welfare is a classic public good. It is non-rival (the happiness I receive from knowing a hen benefits from my consumption of cage-free eggs does not prohibit you from also being happy at the hen's better life) and non-excludable (I cannot keep you from enjoying the fact that I eat cage-free eggs). When a good is non-excludable and non-rival, people can suffer from coordination problems of the sort typified in the prisoners' dilemma. In such cases (and given certain assumptions about preferences), it is possible that everyone would be better off if all were required to purchase cage-free eggs, and yet none actually do so because the individual's incentive is to free-ride off the contributions of others.

Aside from the moral and ethical concerns that accompany the calls for increased animal welfare regulation, the non-market, externality, and public-good food issues represent additional concerns about the outcomes that arise from a competitive market system. The solution that has been sought by many animal welfare groups, notably the HSUS, is to use the state's regulatory power to ban certain production practices such as gestation crates in pork production, battery cages in egg production, and veal crates. A ban can solve the public-good coordination and externality problem by forcing all consumers to buy the products produced under higher levels of animal well-being. A ban, however, is a particularly blunt policy instrument. Not all consumers share the same preferences or

[7] *While this certainly fits the definition of an externality, it is difficult to determine how far such arguments can or should be taken. My decision to wear a brightly colored, neon yellow shirt probably also brings sadness to certain passers-by, but we would not normally "count" this as an externality or market failure. Such observations suggest that issues of externalities become fuzzy when it is unclear where one's property rights begin and end.*

believe that animals suffer in industrial production systems. Moreover, there are a number of non-regulatory options that can help partially mitigate the market failures.

One "solution" to the aforementioned market failures arises from innate human instincts that have arisen over time. As pointed out by Andreoni (1989), we often feel good simply from the *act* of doing the right thing independent on the actual effect on the public good. Such "warm glow" or "impure altruism" motivates humans to give to a public good (for example, to buy cage-free eggs) even when their individual actions only have a tiny marginal effect on the size of the public good (that is, the aggregate level of farm animal well-being). The presence of warm glow implies, for example, that we buy cage-free eggs because it makes *us* feel good, not necessarily because it makes the *chicken* feel good. One interpretation is that warm glow is an emergent preference and one of nature's solutions to helping solve public good problems.

Another innate instinct is the human desire to seek restitution when wronged. Coase (1960) noted that when externalities exist, there are incentives for the affected third-party to negotiate with the offender and force them to internalize costs. Vegans offended by meat-eating have an incentive to negotiate with meat-eaters to seek redress for their grievances. Indeed, many animal advocacy groups directly engage large meat sellers such as McDonalds to enact changes in animal production.

When externalities exist, a natural response of economists is to impose a Pigouvian tax. If the problem is that people are over-consuming meat (from an aggregate utilitarian perspective), then a tax on meat can reduce consumption to levels that more closely approximate the theoretical optimum where all costs are internalized. One difficulty with this tax proposal is that determining the appropriate size of the optimal tax is fraught with challenges and a lack of information, not to mention the fact that the optimal tax will theoretically change over time as market conditions change. Cowen (2006) also pointed out that while a meat tax might lower the *quantity* of animals produced, it will not necessarily improve the *quality* of animals' lives, and could inadvertently lead to substitution toward uses of animals that are even less humane than meat production.

Although it was previously argued that animal welfare is not priced in the market, this is not entirely true. Some attributes related to animal welfare are *indirectly* priced in the market because of food labels. Chang et al. (2010), for example, reported that there were nearly 2,000 Stock Keeping Units (SKUs) of eggs in their scanner data set of egg sales across the U.S. Although the majority of these eggs were un-labeled regarding animal treatment, there were hundreds of SKUs advertising features such as cage-free, free range, vegan fed, natural, and so on. Price differentials between conventional and labeled eggs provide an idea of the implicit price of animal welfare in the market.

Food labels can help solve some of the problems associated with information asymmetry and can also help motivated consumers find products that fit their preferences. Some animal advocacy organizations, such as the Animal Welfare Institute, have helped develop labels such as their Animal Welfare Approved (AWA) label to denote production practices believed to promote higher levels of farm animal welfare. Some retailers such as Whole Foods, which has "animal compassionate" standards, have noted the potential to profit from such labeling and advertising. While labeling

may not completely solve the public good problem, it does suggest the potential for market forces to at least approach the socially-optimal outcome.

One often unappreciated issue is the interplay between different policy options. For example, in the months leading up to the vote on Prop 2 in California, Lusk (2010) showed that demand for cage-free and organic eggs rose relative to demand for conventional eggs. While several factors might explain the change in consumer behavior, one likely explanation relates to the increase in information about egg production practices that came about in the media in response to Prop 2 (see also Tonsor and Olynk 2011). The results from Lusk (2010) suggest that the debate surrounding Prop 2 partially alleviated the need for the proposition in the first place, as it caused consumers to voluntarily shift to those higher-priced options that provide hens more space. Now that Prop 2 has passed, what will happen to the premium previously enjoyed for cage-free and organic eggs, which were often priced at 100% premiums above conventional eggs? One likely outcome is that eggs from the cage-free barn or aviary systems will become the "conventional" or "standard" product, and it is unlikely that these new conventional eggs will support the high prices previously enjoyed in the pre-Prop 2 world. The result is that Prop 2 is likely to cause the profits of "niche" egg producers that provided cage free products prior to Prop 2 to substantially fall. Thus, animal advocacy groups (perhaps inadvertently) brought economic harm to those producers already providing the practices the activists sought to promote.

If the main source of market failure is the lack of a price to steer production and allocation decisions, then one solution would be to create a market for animal welfare that is separate from the market for meat or eggs (see Lusk, forthcoming, for a more complete discussion on this issue). Livestock producers can be conceptualized as producing two outputs that have value for potentially different consumers: meat and animal well-being. Whereas labeling requires a consumer buying meat (or eggs or dairy) to also buy higher levels of animal care, Lusk (forthcoming) proposes a "market for animal welfare" in which units of animal well-being can be bought and sold independent of one's proclivity for eating meat, eggs, or dairy.

The basic idea is that livestock producers are given property rights over the animal welfare produced on their farm. Producers can earn "credits" based on the number of "animal well-being units" produced using the animal welfare production functions of the sort discussed in the preceding sections (for example, Bracke et al. 2002). These credits can then be sold on an exchange to willing buyers such as retailers, animal activist groups, or individual consumers. Although such a market could work on a purely voluntary basis, it is also possible to image cap-and-trade systems along the lines of pollution and carbon trading schemes already in existence.

Consumer Economics

Human Consumers

The bulk of the economic research on animal welfare in recent years has aimed to determine consumer preferences for improved farm animal well-being. For example, in Norwood and Lusk (2011a), we documented almost 35 studies on consumer preferences for animal welfare conducted prior to

2009, and many more have been conducted since then. As another example, Lagerkvist and Hess (2011) conducted a meta-analysis of consumer willingness-to-pay studies on animal welfare using data from 24 studies providing 106 willingness-to-pay estimates. The typical study in this genre measures consumers' willingness-to-pay for improved animal living conditions in the meat or eggs they eat. While many such studies provide useful and important insights relevant to producers and retailers, the studies fail to produce all the information needed to fully complete a cost-benefit analysis. In particular, as we noted in the previous sections, one of the key consumer values relates to altruism toward animals and the so-called "altruistic" or "public good" values consumers place on others increasing their consumption of more animal-friendly products. Indeed, as already discussed, because of the public good problem, consumers might refuse to buy products promoting higher levels of animal well-being in the market (or in a survey or experimental setting) even though they place some positive value on the attribute.

The traditional solution to this problem is to conduct a contingent valuation study, where consumers are asked to value a policy that would uniformly change an animal production practice for all consumers. Consumers' values for the policy are calculated by determining the maximum tax or price increase they would pay to enact the policy. Bennett and Blaney (2003), for example, conducted a mail survey among 591 British households, asking people whether they were willing to pay higher egg prices to phase out the use of cages in egg production; they found consumers were willing to pay 30% higher prices, on average.

One difficulty with studies that ask about consumers' willingness to pay higher egg, meat, or dairy *prices* is that it couples the value of the policy to the commodity itself and does not clearly allow those who eat little (or no) animal products to adequately state their value. For this reason, other studies such as Bateman et al. (2008) have asked about consumers' willingness to let overall food prices or expenditures rise, and Tonsor et al. (2009b) asked about consumers' willingness to allow taxes to rise if a policy improving animal welfare were to pass. The advantage of such contingent valuation studies is that they (at least in theory) have the potential to capture consumers' "private" values and their "altruistic" values toward animals in a setting where free-riding is disallowed (since the question is about a national policy imposed on everyone). The downside is that the questions are hypothetical, and there is substantial evidence showing that willingness-to-pay from hypothetical valuations questions is prone to hypothetical bias, where the values far exceed those that would arise from a non-hypothetical setting (for example, see the meat analysis in List and Gallet, 2001).

One creative approach for determining whether consumers believe there is an externality associated with animal welfare (and thus whether one is in need of more than consumers' "private" values associated with their own willingness-to-pay) was proposed by Carlsson et al. (2007a) in the context of genetically modified food and applied to the topic of animal welfare by Carlsson et al. (2007b) and Tonsor et al. (2009a). The basic idea of the approach is to compare consumers' willingness-to-pay premiums for meat from a cage-free system to their willingness-to-pay premium to live in a world in which the cage-free system is banned for all consumers and producers. The first value reflects a purely voluntary decision associated with

a consumer's willingness to forego money to have higher farm animal well-being in the food they themselves consume; the second value reflects the first value *along with* the consumer's desire to also influence others' purchasing decisions. Thus, if the two values are similar, consumers apparently do not perceive an externality or market failure; if the second value exceeds the first, then this would signal a belief that a market failure exists. Among Swedish consumers, Carlsson et al. (2007b) did not find evidence of a perceived market failure, a result confirmed by Tonsor et al. (2009a) in their study of Michigan consumers. When allowing for consumer heterogeneity, however, Tonsor et al. (2009a) found that approximately 20% of consumers perceived an externality using this method.

The results from Carlsson et al. (2007b) and Tonsor et al. (2009a) suggest that when conducting cost-benefit analysis of policies, it might be appropriate to simply use values from "marketing" studies on consumers' private willingness-to-pay for more animal-friendly products in the meat they eat. Before completely accepting this position, however, it should be noted that there are some drawbacks to this methodology of testing for market failure. First, people may believe an externality exists, but refuse to support a ban because of a perceived option value (i.e., a ban removes a choice option that consumers might later decide they want). Second, the approaches in Carlsson et al. (2007b) and Tonsor et al. (2009a) used a choice experiment where participants were asked to choose between different meat products that had labels like "gestation crate-free" in the voluntary case or "gestation crate banned" in the public policy cases. Rarely are consumers presented with such choices in an actual retail setting because if, say, pork from gestation crates was banned, there would be no "gestation crate" pork available as a comparison or substitute product. Stated differently, consumers are not typically accustomed to making tradeoffs between a label on the one hand, and a ban on the other in the context of their own individual shopping decisions. A final concern with these methods is that, as with the contingent valuation method, they are hypothetical and prone to hypothetical bias.

To address some of the concerns with these previous approaches, Lusk and Norwood (Forthcoming) sought to measure consumers' altruistic values in a non-hypothetical setting by completely disentangling the issue from the eggs and meat that consumers personally eat. In our approach, participants submitted bids in a non-hypothetical experimental auction to move hens (or sows) from a cage (or gestation) production system to a cage-free system with outdoor access. Importantly, these were not bids to have eggs or meat from the systems, but bids to actually move a group of animals from one system to another. As such, the bids do *not* reflect the value consumers place on improved animal welfare in the products they personally consume, but rather reflect (pure and impure) altruism toward animals and the value that consumers place on *other people* consuming products from production systems that produce higher levels of animal well-being. Like Carlsson et al. (2007b) and Tonsor et al. (2009a), we found most people placed only a very small value on the change (for example, the median bid to move 1,000 sows and all their offspring from a gestation crate system to a pasture system was only $1 or $0.001 per sow). However, we found that a small minority of people were willing to pay very high amounts for the change in animal living conditions.

Taken together, the results are suggestive of the notion that concerns about externalities and free-riding, while quite possible in theory, are less likely to be a concern in practice. There are some people who perceive externalities, but they represent a small part of the population. These findings lend some credibility to those who argue for market-based solutions to the animal welfare debate (such as labeling), but as we will discuss more in the last section, such a position assumes all consumers are knowledgeable of animal production practices. Moreover, simply because consumers do not *perceive* an externality does not mean one does not exist, especially when we begin to ask questions about animals' preferences for different living conditions.

We are not naive enough to suggest that estimates of consumer willingness-to-pay employed in cost-benefit analysis are the determinative factor in determining whether an animal welfare policy advances. It often seems that citizens or lawmakers adopt moral reasons for action, and then appeal to cost-benefit ratios if it helps make their case. However, even if policy-makers choose to ignore the results of a cost-benefit analysis, enacted policies use real resources that have real costs that cannot be denied. Thus, knowing how and why consumers value animal welfare can help in suggesting cost-effective actions that attempt to minimize dead-weight losses given the policy objectives.

Animal Consumers

The economists' standard approach to studying consumer behaviour relies on the theory of revealed preferences. If a consumer is seen to choose item A over B, it is presumed the consumer believed themselves to be better off with A over B, all things considered.[8] Observing such choices in the presence of changing prices allows us to estimate consumers' preferences, and project how much better or worse off a consumer would have been given different constraints or prices. The key to the whole approach is the supposition that choices reveal preferences.

If a choice reveals a preference for humans, is the same not true of animals? One prominent group of experimental economists believe the answer to be yes. Kagel et al. (1995) report numerous experiments conducted with animals (mainly pigeons and rats) to test the economic theory developed to explain human behaviour. Overall, their research shows that animal behaviour corresponds quite well with the theoretical predictions, and when animals fail to behave as theory would predict, it is often in tasks where humans do as well (for example, using expected utility theory to explain choices between certain lotteries).

Physiologists, biologists, and animal scientists have been conducting animal preference studies for years (Dawkins 1977; Kirkden and Pajor 2006; Matthews and Ladewig 1994). For example, in an aptly named article

[8]*Philosophers refer to this concept as The Principle of Charity – interpreting others' choices as arising from some rational process. As Huemer (2005, p. 160) put it, "The principle is not that all actions or beliefs are rational, but only that we should interpret others to be by and large rational, if possible." Some version of the principle is required to meaningfully interpret others' behaviors. Without it, when we see a friend eating a piece of chocolate cake, we "might instead hypothesize that she . . . likes swimming in the [English] Channel, so that is why she eats the chocolate." Heumer (p. 160) concluded: "we need to assume others are at least generally rational in order to select an appropriate account of their behavior from the indefinitely many possible accounts."*

titled "Battery Hens Name Their Price," Dawkins (1983), gave hens a choice between entering two cages. Cage 1 had bedding (or litter) but no food. Cage 2 had only a wire floor but had 250g of the birds' standard food. Thus, the hen faced a tradeoff between more food and more comfortable flooring. The choices were run under two conditions: the first when hens had been deprived of food, and the second when they had not. Most of the birds chose the cage with the litter unless they had been food-deprived. Dawkins concluded that, "although hens prefer litter to wire floors, their preference is not strong enough to outweigh the attraction of food unless the birds are not deprived of food at all," (p. 1201).

Although Dawkins (1983) did not do this in her study, it is relatively straightforward to see how similar experiments could be conducted varying the amount of food available in the wire cage (or the degree of hunger of the hens) to gain an explicit functional form for the trade-off between quantity of food desired and preference for flooring. Such a relationship would reveal the same information as contained in an indifference curve: the marginal rate of substitution between food and flooring. Indeed, studies such as that by Matthews and Ladewig (1994) calculated "demand curves" by, in their case, seeing how many times a hog was willing to press a lever (the hog's effort is analogous to a price paid) to obtain different items such as food or social contact with other animals.

Regular human willingness-to-pay is nothing more than a marginal rate of substitution between one attribute and money. In the case of animals, we also have a willingness-to-pay, but the units are in terms of quantity of food rather than quantity of dollars.[9] As discussed in Lusk and Norwood (2011), however, we can convert an animal's marginal rate of substitution to dollars by noting that their food, mainly corn, has a market price which embodies the all-animal (and human) demand for corn. In so doing, one can obtain an estimate of animals' willingness-to-pay (in dollars) for the commodity in question. Although we are aware of economists conducting experiments with animals to test economic theories of consumer choice (for example, Kagel et al. 1995) and of animal scientists conducting experiments with animals to determine relative preferences for different components of a production system, we are unaware of joint efforts to determine the economic value animals place on production systems similar to the kind of human consumer preference work done for cost-benefit analysis. This is an area that is ripe for future research, especially for those interested in non-speciest cost-benefit analysis.

Conclusions

In our assessment, farm animal welfare is a topic of increasing importance to agricultural producers that is likely to be with us for some time. We have hopefully demonstrated that economists have an important role to play in shaping debate on the topic. Economists' contributions at this point, however, remain relatively few and far between. As Lagerkvist and Hess (2011, p. 72) put it, "The economics literature on WTP [willingness-to-pay] for FAW [farm animal welfare], according to our

[9]*In the Matthews and Ladewig (1994) study, preferences are cast in terms of "effort," but one can convert this to units of food by dividing the effort exerted to obtain one outcome (such as more space) by the effort exerted to obtain food.*

literature sample, appears much smaller than public attention to this topic would suggest."

We have already mentioned several areas that require additional research, and we will conclude with a few more thoughts on the matter. One of the thorniest issues arising in the study of consumer preferences for animal welfare is that people simply do not know much about how farm animals are raised. Indeed, data from our studies show that most consumers have an overly optimistic view of production agriculture, believing many more animals are raised in free-range type systems than actually are. This knowledge problem presents significant challenges to carrying out cost-benefit analyses of animal welfare policies (see Foster and Just 1989 for the conventional approach to valuing information for experience goods). Data suggest that most consumers, when informed about modern production practices such as battery cages or gestation crates, express a willingness-to-pay for the more "humane" alternatives that exceeds the costs of providing them. However, most consumers are not informed and will never become so. The market share of cage-free and organic meat and egg products is far lower than what would seem to be suggested by people's behavior in voting booths on animal welfare policies. It also seems difficult to imagine that a cost-of-ignorance or value-of-information sort of analysis would justify policy changes, as animal welfare is – from the perspective of human consumers – a credence good for which they will never know whether they consumed a "lower quality" product. Attempting to resolve some of these philosophical and economic paradoxes present a significant challenge for future research.

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References

Alston, J.M. 1991. Research Benefits in a Multimarket Setting: A Review. *Review of Marketing and Agricultural Economics* 59(1):23–52.

Andreoni, J. 1989. Giving with Impure Altruism: Applications to Charity and Ricardian Equivalence. *Journal of Political Economy* 97(6):1447–1458.

Appleby, M.C., and B.O. Hughes 1997. *Animal Welfare*. Cambridge, UK: CABI Publishing.

Bateman, I.J., D. Burgess, W.G. Hutchinson, and D.I. Matthews 2008. Learning Design Contingent Valuation (LDCV): NOAA Guidelines, Preference Learning and Coherent Arbitrariness. *Journal of Environmental Economics and Management* 55 (2):127–141.

Bennett, R.M. 1995. The Value of Farm Animal Welfare. *Journal of Agricultural Economics* 46(1):46–60.

——. 1997. Farm Animal Welfare and Food Policy. *Food Policy* 22(4):281–288.
Bennett, R.M., and R.J.P. Blaney 2003. Estimating the Benefits of Farm Animal Welfare Legislation Using the Contingent Valuation Method. *Agricultural Economics* 29(1):85–98.
Bennett, R.M., and D. Larson 1996. Contingent Valuation of the Perceived Benefits of Farm Animal Welfare Legislation: An Exploratory Survey. *Journal of Agricultural Economics* 47(1–4):224–235.
Bergstrom, T.C. 2006. Benefit-cost in a Benevolent Society. *American Economic Review* 96(1):339–351.
Botreau, R., M. Bonde, A. Butterworth, P. Perny, M.B.M. Bracke, J. Capdeville, and I. Veisser 2007a. Aggregation of Measures to Produce an Overall Assessment Of Animal Welfare. Part 1: A Review of Existing Methods. *Animal* 1(8):1179–1187.
Botreau, R., M.B.M. Bracke, P. Perny, A. Butterworth, J. Capdeville, C.G. Van Reenen I. Veisser 2007b. Aggregation of Measures to Produce an Overall Assessment Of Animal Welfare. Part 2: Analysis of Constraints. *Animal* 1(8):1188–1197.
Bracke, M.B.M., B.M. Spruijt, J.H.M. Metz, and W.G. P. Schouten 2002. Decision Support System for Overall Welfare Assessment In Pregnant Sows A: Model Structure And Weighting Procedure. *Journal of Animal Science* 80:1819–1834.
Broom, D.M., and K.G. Johnson 1993. *Stress and Animal Welfare*. Norwell, MA: Kluwer Academic Publishers.
Carlsson, F., P. Frykblom, and C.J. Lagerkvist 2007a. Consumer Benefits of Labels and Bans on GM Foods-Choice Experiments with Swedish Consumers. *American Journal of Agricultural Economics* 89(1):152–161.
——. 2007b. Farm Animal Welfare-Testing for Market Failure. *Journal of Agricultural and Applied Economics* 39(1):61–73.
Chang, J.B., J.L. Lusk, and F.B. Norwood 2010. The Price of Happy Hens: A Hedonic Analysis of Retail Egg Prices. *Journal of Agricultural and Resource Economics* 35(3):406–423.
Coase, R.D. 1960. The Problem of Social Cost. *Journal of Law and Economics* 3:1–44.
Cowen, T. 2006. Market Failure for the Treatment of Animals. *Society* 43(2):39–44.
Curtis, S.E. 2007. Commentary: Performance Indicates Animal State of Being: A Cinderella Axiom? *Professional Animal Scientist* 23(6):573–583
Dawkins, M.S. 1977. Do Hens Suffer in Battery Cages? Environmental Preference and Welfare. *Animal Behavior* 25(4):1034–1046.
——. 1980. *Animal Suffering: The Science of Animal Welfare*. London: Chapman and Hall.
——. 1983. Battery Hens Name Their Price: Consumer Demand Theory, The Measurement of Ethological 'Needs'. *Animal Behaviour* 31(4):1195–1205.
De Mol, R.M., W.G.P. Schouten, E. Evers, H. Drost, H.W.J. Houwers, and A.C. Smits 2006. A Computer Model for Welfare Assessment of Poultry Production Systems for Laying Hens. *Netherlands Journal of Agricultural Science* 54(2):157–168.
Foster, W., and R. Just 1989. Measuring Welfare Effects of Product Contamination with Consumer Uncertainty. *Journal of Environmental Economics and Management* 17(3):266–283.
Harrison, R. 1964. *Animal Machines: The New Factory Farming Industry*. London: Vincent Stewart Publishers.
Hertel, T.W., ed. 1997. *Global Trade Analysis: Modeling and Applications*. Cambridge: Cambridge University Press.
Huemer, M. 2005. *Ethical Intuitionism*. New York: Palgrave MacMillan.
Hicks, J. 1939. The Foundations of Welfare Economics. *Economic Journal* 49(196):696–712.
Jones-Lee, M.W. 1992. Paternalistic Altruism and the Value of a Statistical Life. *Economic Journal* 102(410):80–90.

Kagel, J.H., R.C. Battalio, and L. Green 1995. *Economic Choice Theory: An Experimental Analysis of Animal Behavior* Cambridge, UK: Cambridge University Press.

Kaldor, N. 1939. Welfare Propositions in Economics and Interpersonal Comparisons of Utility. *Economic Journal* 49(195):549–552.

Kirkden, R.D., and E.A. Pajor 2006. Using Preference, Motivation and Aversion Tests To Ask Scientific Questions about Animals' Feelings. *Applied Animal Behaviour Science* 100(1–2):29–47.

Lagerkvist, C.J., and S. Hess 2011. A Meta-Analysis of Consumer Willingness to Pay for Farm Animal Welfare. *European Review of Agricultural Economics* 38(4):55–78.

List, J.A., and C.A. Gallet 2001. What Experimental Protocol Influence Disparities Between Actual and Hypothetical Stated Values? *Environmental and Resource Economics* 20(3):241–54.

Lusk, J.L. 2010. The Effect of Proposition 2 on the Demand for Eggs in California. *Journal of Agricultural and Food Industrial Organization*. 8(1), Article 3.

——. Forthcoming. The Market for Animal Welfare. *Agricultural and Human Values*.

Lusk, J.L., and F.B Norwood Forthcoming. Speciesism, Altruism, and the Economics of Farm Animal Welfare. *European Review of Agricultural Economics*.

Matheny, G. 2006. Utilitarianism and Animal. *In Defence of Animals: The Second Wave*.Peter Singer, ed. Malden, MA: Blackwell Publishing.

Matthews, L.R., and J. Ladewig. 1994. Environmental Requirements of Pigs Measured by Behavioural Demand Functions. *Animal Behavior* 47(3):713–719.

McInerney, J.P. 1993. Animal Welfare: An Economic Perspective. Paper delivered to the Annual Conference of the Agricultural Economics Society. Oxford, April 1993.

Norwood, F.B, and J.L. Lusk. 2011a. *Compassion by the Pound: The Economics of Farm Animal Welfare*. Oxford, UK: Oxford University Press.

——. 2011b. A Calibrated Auction-Conjoint Valuation Method: Valuing Pork and Eggs Produced under Differing Animal Welfare Conditions. *Journal of Environmental Economics and Management* 62(1):80–94.

Regan, T. 2004. *The Case for Animal Rights*. Berkeley, CA: University of California Press.

Singer, P. 1975. *Animal Liberation.* New York: Avon.

——. 2002. *Animal Liberation.* New York: HarperCollins.

Sumner, D.A., J.T. Rosen-Molina, W.A. Matthews, J.A. Mench, and K.R. Richter 2008 Economic Effects of Proposed Restrictions on Egg-laying Hen Housing in California. Working paper, University of California Agricultural Issues Center. University of California, Davis, July.

Sunstein, C., and M. Nussbaum, eds. 2005. *Animal Rights: Current Debates and New Directions*Oxford: Oxford University Press.

Tonsor, G.T., and N.J. Olynk. 2011. Impacts of Animal Well-Being and Welfare Media on Meat Demand. *Journal of Agricultural Economics* 62(1):59–72.

Tonsor, G.T., N.J. Olynk, and C. Wolf. 2009a. Consumer Preferences for Animal Welfare Attributes: Case of Gestation Crates. *Journal of Agricultural and Applied Economics* 41(3):713–730.

Tonsor, G.T., C. Wolf, and N. Olynk. 2009b. Consumer Voting and Demand Behavior Regarding Swine Gestation Crates. *Food Policy* 34(6):492–498.

Ursinus, W. W., F. Schepers, R. M. Mol, M. B. M. de Bracke, J. H. M. Metz, and P. W. G. G. Koerkamp. 2009. COWEL: A Decision Support System to Assess Welfare of Husbandry Systems for Dairy Cattle. *Animal Welfare* 18(4):545–552.

Wohlgenant, M.K. 2011. Consumer Demand and Welfare in Equilibrium Displacement Models. In *The Oxford Handbook of the Economics of Food Consumption and Policy*, J.L. Lusk, J. Roosen, and J.F. Shogren, eds. Oxford: Oxford University Press.