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An Economic Model of the Meat Paradox

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An economic model of the meat paradox [*]

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Abstract

Many individuals have empathetic feelings towards animals but frequently consume meat. We investigate this "meat paradox" using insights from the literature on motivated reasoning in moral dilemmata. We develop a model where individuals form self-serving beliefs about the suffering of animals caused by meat consumption in order to alleviate the guilt associated with their dietary choices. The model makes several specific predictions: in particular, it predicts a positive relationship between individuals' taste for meat and their propensity to engage in self-deception, a high price elasticity of demand for meat, and a causal effect of prices and aggregate consumption on individual beliefs.

Keywords: motivated reasoning, moral dilemmata, self-deception, meat paradox, meat price-elasticity, animal welfare
JEL Codes: D72, D81, D83, D84, Z13

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1   Introduction

Meat has been part of the diet of most human societies (Stanford and Bunn, 2001; Burgat, 2017), and is still omnipresent in human culture (e.g., in holiday meals). Yet, the consumption of meat requires animals to be raised and killed and can be viewed as a morally problematic activity. Most people are emotionally disturbed when made aware of the suffering of animals associated with modern industrial farming practices (Plous, 1993). Individuals who care about the well-being of animals face a trade-off in their consumption choice between the utility derived from eating meat and the psychological disutility implied by their awareness of the suffering inflicted on farm animals.

The objective of this paper is to investigate the relationship between individuals' consumption of meat and their perception of the well-being of animals raised for consumption. We introduce a behavioral model of demand for meat in which individuals form self-serving beliefs to reduce the guilt associated with the negative externalities inflicted on animals. This model enables us to make predictions on the link between consumers' preferences and beliefs, as well as on consumers' reaction to exogenous parameters, such as the price of meat.

Exploring the determinants of meat consumption is important for several reasons. First, the meat industry represents a significant fraction of our economic activity; in the US, it accounts for about 6% of the US GDP, including direct and indirect revenues (see NAMI, 2013). However, the future of the sector is in question due to the increasing proportion of vegetarians in the population and the growing awareness of the negative impacts of meat consumption (The Economist, 2018). Among the different reasons commonly proposed to reduce meat consumption, such as environmental externalities, or negative effects on consumers' health, the moral dimension plays an important role (Ruby, 2012). Increasingly, animal rights organizations provide consumers with information about the harsh living conditions of animals in the farming industry, and animal sciences demonstrate animals' capacity to suffer physically and emotionally (Low et al., 2012; Ritvo, 2007). If innovations such as plant-based proteins or cultured meat become an affordable substitute for meat in the future, consumers will have to choose between "meat" produced with or without the use of animals. The moral dimension could then be one of the chief determinants of this choice.

Second, meat consumption concerns the daily choices of billions of individuals. It thus offers an important application of a recent literature in psychology and behavioral economics that studies individuals' behavior in situations of moral dilemmata.

This literature, reviewed in Section 2, documents that individuals have a tendency to form self-serving beliefs that understate the negative consequences of their actions on others. In the case of meat consumption, this behavioral phenomenon has recently received some attention in psychology, as a potential explanation for the "meat paradox" (Loughnan et al., 2010).

We develop a model of demand for meat inspired by the literature on motivated reasoning. According to this explanation, individuals deny objective information regarding the living conditions of animals in order to alleviate the feeling of guilt that they experience when they consume meat. The amount of meat consumed by an individual thus has a causal effect on their perception of animal welfare.

Our model works as follows. An individual selects a quantity of meat for consumption at a unit price p. Consuming a quantity c of meat delivers some utility $U(c)$, but inflicts a moral cost $\omega x c$ to the agent: ω is the extent to which the individual feels empathetic towards animals and internalizes their suffering, or to which the individual feels guilty about her consumption, whereas x measures the perceived intensity of the externality inflicted on animals as a result of meat consumption. The variable x is uncertain ex ante, and encompasses all the parameters pertaining to the perception of the consequences of meat consumption: whether animals are able to feel physical and emotional pain, how much livestock suffer from farming practices, the extent to which consuming meat is necessary for good health, etc. The core of the model, in line with micro-level evidence on information processing in situations of moral dilemmata, is that individuals do not care about the "true" value of x but only about their perception of it. As a result, they have incentives to manipulate their own expectation of x in order to keep consuming large quantities of meat without feeling too guilty about it.

We model information processing as an intra-personal game, adapting the architecture of the model of motivated beliefs provided by Bénabou and Tirole (2002).[1] The consumer has two selves. Self 0 receives some information about the true value of x, and decides either to transmit the information to Self 1, or to conceal it, at some cost of self-deception. Self 0 only cares about Self 1's perception of x and thus has an incentive to manipulate information transmission. We focus on Self 0's choice of whether to transmit or conceal bad news, i.e. signals that indicate a large externality and therefore prescribe a low consumption of meat. In equilibrium, individuals who decide to engage in self-deception are biased in their perception of the externality imposed on animals, and form different beliefs from those of realistic

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[1]See also Bénabou and Tirole (2006), Bénabou and Tirole (2011), Bénabou (2013), Levy (2014), and Le Yaouanq (2018) for applications of this model.

individuals, even though all agents have received the same piece of information in the first place.

The model makes the following predictions. First, there is a negative association between individuals' subjective expectation of x and their consumption of meat. This result is due to the fact that individuals with a larger taste for meat are more likely to engage in self-deception, since the marginal benefit of denying the moral externality is the largest for these individuals. In turn, these optimistic beliefs increase demand for meat relative to their realistic peers. Individuals who consume a large quantity in equilibrium are therefore likely to understate the suffering of animals, whereas individuals who consume small quantities have little incentives to form distorted beliefs.

Second, consumers become more realistic when the price of meat increases. Intuitively, an increase in the price of meat makes consumption less appealing, and therefore the incentives to deny the negative consequences of consumption also shrink. The model therefore predicts that variations in prices, an exogenous parameter, influence individuals' perception of animal welfare. This contrasts with the standard theory of belief formation, in which variations in prices do not have any effect on consumers' beliefs.[2]

Third, we investigate how consumers react to variations in the cost of guilt ω. This comparative statics result is useful for predicting which consumers are the most likely to form distorted beliefs, or for predicting the effect of an external increase in the social stigma borne by meat eaters (for instance, following advertising campaigns by animal rights activists). Perhaps surprisingly, we show that an increase in ω does not necessarily make the consumer more realistic: this intuition holds true if and only if the consumer's demand for meat is sufficiently elastic. A consumer with an elastic demand can easily adapt to changes in ω by reducing consumption, which therefore lowers the need to engage in self-deception. In contrast, a consumer whose demand is inelastic will ultimately decide to maintain a high consumption level following a variation in ω, and therefore feels a higher need to alleviate the guilt generated by her consumption. Our results thus imply that the effectiveness of campaigns designed to induce guilt is mediated by the elasticity of preferences.

Fourth, we examine the agents' ex-ante attitude towards information. In a standard model, consumers are (weakly) better off when they receive some information about the consequences of their actions, and they should thus be willing to acquire information about the living conditions of livestock. Things are different if individu-

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[2]The idea that prices influence (motivated) beliefs also appeared in Schwardmann (2019) in the context of preventative health care.

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als form motivated beliefs, as already noticed by the literature in different contexts (see for instance Bénabou and Tirole, 2002; Grossman and van der Weele, 2017; and Golman et al., 2017 for a survey). The attitude towards information takes a simple form in our model: individuals are information-loving if their equilibrium strategy is to accept bad news, and information-averse if their equilibrium strategy is to deny bad news. Intuitively, individuals who deny bad news are harmed by the information, which does not affect their actions but forces them to engage in an active process of self-deception.

Fifth, and finally, we examine in an extension a model in which a group of identical individuals interact. Bénabou (2013) demonstrated that denial can be contagious in a setting where individuals engaged in a collective project can resort to wishful thinking to protect their anticipatory feelings. We show that a similar complementarity of cognitive strategies arises in our context, with a different foundation. We assume that individuals' utility is affected by the aggregate consumption of meat in society, and not solely by the externality generated by their own consumption. On top of the direct consumption externality, individuals observe the meat consumption of others and may learn the true state of animal suffering from that observation. We show that two symmetric equilibria can coexist, one equilibrium featuring collective realism and one equilibrium of collective denial. Under denial, learning opportunities are limited as others' actions are insensitive to the true state of the world, and externalities imposed on animals are high, making incentives to deny bad news higher.

Section 2 reviews the relevant literature. Section 3 introduces the model, the results of which are presented in Section 4. We conclude the paper in Section 5 with a discussion of the model.

2   Related literature

In this section we provide a two-part review of the relevant literature. We start with the evidence documenting the importance of moral aspects in meat consumption, and we then proceed with the literature on motivated beliefs in moral dilemmata produced by economists and social psychologists.

2.1   Moral consequences of meat consumption

A lot of casual evidence suggests that individuals hold empathetic feelings towards animals. For instance, there exist more than 60 million domestic dogs in

the US, and many of them are treated as family members, receiving for instance a birthday or a Christmas present (Coate and Knight, 2010). Wild animals, too, are regularly the center of media attention and widespread sympathy, as documented by the recent scandal about the shooting of Cecil, the lion, which provoked responses of reprobation and anger by scores of individuals around the globe. Francione (2004) reports that two-thirds of Americans polled by the Associated Press agree with the following statement: "An animal's right to live free of suffering should be just as important as a person's right to live free of suffering". Yet, every year billions of animals are raised in industrial farming facilities for their meat. This situation illustrates the apparent discrepancy between individuals' attitude towards animals and the consequences of their daily actions. It has been the object of a recent strand of academic research in psychology referring to "the meat paradox" (Loughnan et al., 2010).

The importance of moral concerns in meat consumption decisions is exemplified by the fact that omnivores and vegetarians have systematically different beliefs about and attitudes towards animals. Vegetarians are more likely than omnivores to admit that animals raised for food have the capacity to suffer (Bratanova et al., 2011). Rothgerber (2014) reports a positive correlation between meat consumption and agreement with statements such as "animals don't really suffer when being raised and killed for meat" and "animals do not feel pain the same way humans do". In their survey studies, Bilewicz et al. (2011) report that vegetarians and omnivores attribute different emotional capacities to different animals. They find for instance that omnivores, unlike vegetarians, draw a line between the emotions of meat versus non-meat animals (Bilewicz et al., 2011). Many vegetarians indicate that the ethical dimension is a key driver of their consumption choices: many stopped eating meat after a "shock", for instance after being exposed to the slaughter of an animal, witnessing violence towards animals, or reading an influential book such as those of Pollan (2006) and Safran Foer (2010).

Most accounts of the meat paradox postulate that individuals engage in a self-serving rationalization process by which they distort their own perception of animals (e.g., of their capacity to suffer) and of industrial farming practices in order to justify their consumption of meat. While the evidence described above is consistent with motivated reasoning, it does not by itself rule out more standard alternatives. For instance, the disagreement and difference in behavior between vegetarians and omnivores could be due to heterogeneous private information, instead of being driven by self-serving moral reasoning. However, a series of experiments documents that beliefs about animals are easily malleable and affected by treatment manipulations

that do not provide any legitimate information about animals or industrial farming, but vary the perceived moral consequences of meat consumption. In particular, individuals tend to ascribe lower cognitive ability and capacity to suffer to animals that are used for human consumption.

Bastian et al. (2012) reports a negative correlation between animals' edibility and their perceived mental capacities. This is illustrated on Figure 1: Dogs, cats and horses, as well as monkeys and lions, for instance, score high on cognitive ability, and low on edibility, while chicken, cows and sheeps score high on edibility, but low on cognitive ability. Bratanova et al. (2011) provide causal evidence for this relationship. They exogenously manipulate whether an animal is presented as "food", whether the animal has been killed or not, and whether humans are responsible for its death. They find that categorizing an animal as "food" reduces the animal's perceived capacity to suffer, and, in turn, reduces people's moral concern for this animal.[3] Bastian et al. (2012) also document that people ascribe fewer mental capacities to an animal (a sheep or a cow) when they are reminded that the animal will be used for meat consumption. In a follow-up experiment, Bastian et al. (2012) randomly assign subjects to a condition where they would have to eat cold cuts of roast beef, or to a condition where they would have to eat slices of apple. Prior to eating the food, subjects are given the chance to rate the moral capacities of cows. Participants who expect the opportunity to eat beef in the immediate future report lower cognitive capacities for cows. Loughnan et al. (2010) also find that subjects who were offered "beef jerky" at the beginning of the experiment report later a lower moral concern for animals (in particular, for cows) than those who were offered "dried nuts".[4]

Another finding inconsistent with the Bayesian model of belief formation is that many consumers appear to be *willfully ignorant* about the realities of animal welfare in industrial farming. Among the 1,000 respondents surveyed in Oklahoma by Bell et al. (2017), about one-third prefer looking at a blank screen rather than receiving information about how swine are raised.[5] In addition, a substantial fraction report that they do so in order not to feel guilty when they purchase meat in the future. Together, information avoidance and the sensitivity of beliefs to manipulations of the perceived moral consequences of eating meat substantiate the role of self-serving belief formation, which is the key ingredient of the model developed in Section 3.

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[3]However, they do not find any effect of the two other treatments.

[4]Nevertheless, the treatment did not significantly affect beliefs about cows' cognitive ability and capacity to experience a variety of mental states such as happiness, pain, etc.

[5]See also Onwezen and van der Weele (2016), who report that 27% of people confess that they remain willfully ignorant about animal farming.
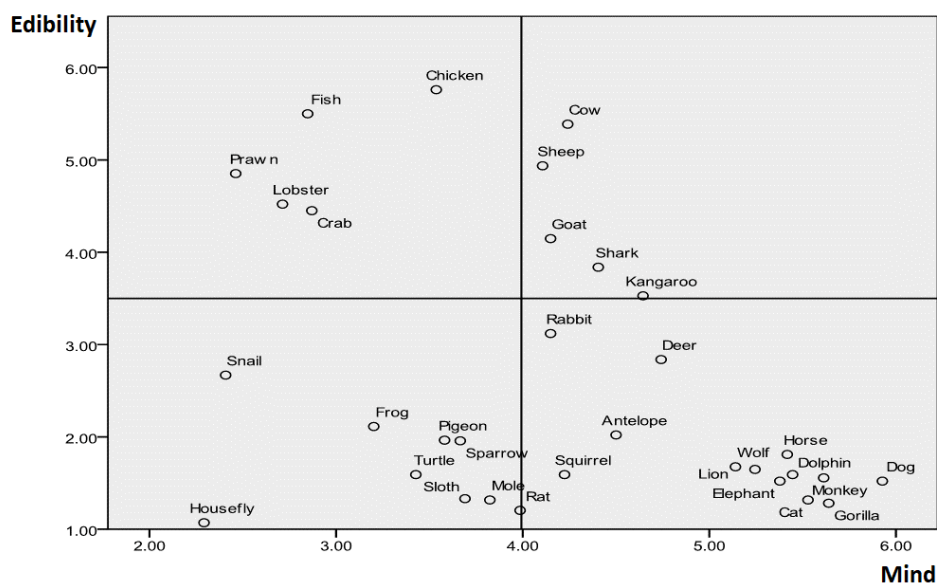
Figure 1 – Source: Bastian et al. (2012) The graph displays ratings given to different animal species regarding their cognitive abilities ("Mind", measured on the horizontal axis) and their edibility, measured on the vertical axis.

2.2 Motivated beliefs in moral dilemmata

Researchers from several disciplines (economics, philosophy, psychology) have long debated the nature of pro-social preferences, with a particular interest in the sincerity of other-regarding behavior. Recent research supports the view that, in many situations of interest, individuals like to *feel* altruistic, or at least moral, without necessarily *being* altruistic, as evidenced by their strategic use of uncertainty or other contextual excuses to rationalize their opportunistic behavior (Dana et al., 2007; Exley, 2015), or their avoidance of situations where a pro-social action is expected (DellaVigna et al., 2012; Andreoni et al., 2017). To resolve the tension between a desire to pursue one's material interest and the belief that a pro-social action is morally appropriate, individuals tend to form self-serving fairness judgments and beliefs about the consequences of their actions on others, in order to justify selfish behavior (see Andreoni and Sanchez, 2014; Di Tella et al., 2015 for examples, and Gino et al., 2016 for a survey). Another facet of this strategy is that many individuals actively avoid information about the externalities generated by their actions (Dana et al., 2007; Shu and Gino, 2012; Van der Weele, 2014), and seek pre- or post-justifications to downplay a moral violation (Barkan et al., 2015; Shalvi et al., 2015).

Several papers have analyzed the role of self- or social image in shaping individuals' perceptions in moral dilemmata. Grossman and van der Weele (2017) show

that individuals motivated by self-image concerns might avoid information about the externalities generated by their actions and behave selfishly. Bénabou et al. (2018) and Foerster and van der Weele (2018a) analyze belief formation in settings where individuals communicate about the magnitude of the externality (see also the experiment by Foerster and van der Weele, 2018b). Our model focuses on individual belief formation and relies on a different foundation than these papers, as the utility-relevance of beliefs is due to a cost of guilt caused by consumption rather than an image component. The focus on a specific consumption problem also allows us to derive new predictions, such as the effect of prices on beliefs.

Our theory builds on a growing literature in behavioral economics that departs from the classical view that beliefs are a function of information only, and that models belief formation as the result of a (constrained) optimization problem (see the survey by Bénabou and Tirole, 2016). Formally, our model builds on the architecture proposed by Bénabou and Tirole in a series of papers,[6] in which beliefs are the outcome of an intrapersonal Bayesian equilibrium. However, the insights of the theory are robust to other specifications of the process of belief formation, such as the one proposed by Brunnermeier and Parker (2005) in which individuals are free to choose their beliefs without any constraint (see the supplementary appendix).

3   Model

3.1   Primitives

Information and preferences   An individual selects a quantity $c \in \mathbb{R}_+$ of meat available at a unit price $p \geq 0$. Her taste for meat is represented by the utility function $U : \mathbb{R}_+ \to \mathbb{R}$ defined over her consumption level c. The function U is twice continuously differentiable and satisfies $U' > 0, U'' < 0$, and $U'(0) < +\infty$.

On top of the material component $U(c) - pc$, the individual's preferences include some moral concerns: she feels guilt from being responsible for externalities imposed on animals. However, she is uncertain about the true level of the externality associated with meat consumption: for instance, she is unsure about the conditions under which animals are raised, about their capacity to feel pain and pleasure, etc. All the uncertainty is captured by a single random variable X, which takes a high value $X = x_H > 0$ or a low value $X = x_L$ ($0 < x_L < x_H$) with equal prior probabilities. The agent's consumption of meat c generates a negative externality equal to $-Xc$. The states $X = x_H$ and $X = x_L$ convey different moral obligations: the externality

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[6]See Bénabou and Tirole (2002); Bénabou and Tirole (2004); Bénabou and Tirole (2006); Bénabou and Tirole (2011), and Bénabou (2013).

inflicted on animals by meat consumption is greater if $X = x_H$. However, since the individual is uncertain about the state, she evaluates the externality according to her subjective expectation $\tilde{x} = \mathbb{E}X$ and incurs a moral cost of guilt equal to $-\omega\tilde{x}c$. The parameter $\omega \geq 0$ represents the individual's degree of morality, or the extent to which she internalizes the externality in her behavior. The individual's prior expectation of X equals $1/2 x_L + 1/2 x_H$. All in all, c is selected according to the following problem:

$$\max_{c \in \mathbb{R}_+} U(c) - pc - \omega\tilde{x}c. \tag{1}$$

We write $c^*(\tilde{x})$ for the (unique) optimal solution of this program when the individual has perception $\tilde{x}$ at the time of choice. Equation 1 yields

$$c^*(\tilde{x}) = \max\left\{(U')^{-1}(p + \omega\tilde{x}), 0\right\}. \tag{2}$$

The optimal consumption level $c^*(\tilde{x})$ is decreasing with all three variables p, ω and $\tilde{x}$. We also write

$$V(\tilde{x}) = U(c^*(\tilde{x})) - (p + \omega\tilde{x})c^*(\tilde{x}) \tag{3}$$

for the perceived indirect utility defined as a function of beliefs. The function V is nonincreasing in $\tilde{x}$.

Timeline The formation of beliefs is modeled as the result of an intra-personal game played by two successive incarnations (Self 0 and Self 1) of the same individual. At date 0, Self 0 receives some information about X. For instance, she might learn about the living conditions of the cattle, watch a video recorded in a slaughterhouse, or learn some information about animals' capacity to experience pain and pleasure. For simplicity, we assume that the signal takes only two values: bad news ($m = m_H$), or good news ($m = m_L$). The signal is perfect, that is, characterized by $p(m = m_H \mid X = x_H) = p(m = m_L \mid X = x_L) = 1$. A signal $m = m_H$ is thus to be interpreted as an indication that the externalities of meat consumption are large, whereas a signal $m = m_L$ indicates that the externalities are small.

At date 1, once the individual has formed her beliefs she selects c according to Equation 2 and receives her consumption utility. The moral cost is paid at date 2.
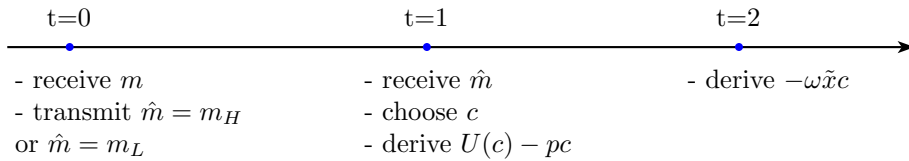

t=0	t=1	t=2
- receive m	- receive $\hat{m}$	- derive $-\omega\tilde{x}c$
- transmit $\hat{m} = m_H$	- choose c	
or $\hat{m} = m_L$	- derive $U(c) - pc$	

Figure 2 – Timeline

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Motivated reasoning In line with the literature on motivated beliefs formation, we assume that the individual has the desire and the capacity to distort her perception of the consequences of her actions. We assume that good news $m = m_L$ are truthfully encoded by the decision-maker and focus on her reaction to bad news $m = m_H$. When she receives the message $m = m_H$, she might either incorporate this piece of information into her beliefs; or, she might incur an effort in order to repress the signal, look actively for contradicting pieces of evidence, or engage in any other self-deception strategy that downplays the meaning of the information she just received. We follow the memory-management model proposed by Bénabou and Tirole and model the choice of information processing in an intrapersonal game-theoretic framework. When Self 0 receives the signal $m = m_H$, she can either truthfully transmit $\hat{m} = m_H$ to her future incarnation or mis-encode the signal and transmit $\hat{m} = m_L$ at a psychic cost $k \geq 0$ instead. The parameter k (see Equation 5 below) represents the hedonic disutility incurred by the individual if she engages in self-deception.

The individual is forward-looking when she selects $\hat{m}$. More precisely, she anticipates that her cognitive choice will affect the consumption level $c(\tilde{x})$ selected by her incarnation at date 1, as well as the moral cost of guilt $\omega\tilde{x}c(\tilde{x})$ that she will incur. By denying the "bad news" $m = m_H$, the individual alleviates her perceived moral obligations towards animals, and can thus select a higher level of meat consumption.

3.2 Equilibrium concept

The cognitive decision $\hat{m}$ at date 0 is modeled as the equilibrium outcome of the interaction between the individual's Self 0, who chooses the information, and the individual's Self 1, who makes the consumption decision. We make two important assumptions regarding this interaction. First, Self 0 fully internalizes Self 1's perceived utility of consumption without taking into account the true value of the externality. For instance, if Self 0 believes that $X = x_H$ but deceives Self 1 into thinking that $\mathbb{E}X = \tilde{x}$, Self 0 receives the utility

$$U(c^*(\tilde{x})) - (p + \omega\tilde{x})c^*(\tilde{x}).$$

By contrast, if Self 0 were concerned about the true state of the world (and not only about Self 1's perception of it), she would derive the utility

$$U(c^*(\tilde{x}) - (p + \omega x_H)c^*(\tilde{x}).$$

and there would be no scope for self-deception, as truthful encoding would be optimal. Motivated reasoning arises in this model since the individual is only concerned by her future perception when she chooses her beliefs.

Second, the two players (Self 0 and Self 1) are strategic and Bayesian. In particular, Self 1 performs Bayesian updating when she receives good news ($\hat{m} = m_L$) and considers the possibility that her Self 0 has mis-encoded a signal $m = m_H$. This assumption of sophistication constrains the self-deception process but does not eliminate the possibility to distort one's beliefs. Following the message $\hat{m} = m_H$, Self 1's perception is equal to x_H. Following the message $\hat{m} = m_L$ and given Self 0's habitual strategy σ, Self 1 forms an expectation equal to

$$\tilde{x}(\sigma) := \frac{1-\sigma}{2-\sigma} x_H + \frac{1}{2-\sigma} x_L. \tag{4}$$

The posterior expectation $\tilde{x}(\sigma)$ is decreasing in σ: the higher the individual's habitual probability of transmitting bad news, the more the individual trusts her recollection $\hat{m} = m_L$ and believes that the message sent was uninformative. In contrast, an individual who always denies bad news ($\sigma = 0$) stays with her prior beliefs irrespective of her recollection.

We look for Perfect Bayesian Equilibria of this game. An equilibrium is characterized by: (i) Self 0's probability $\sigma \in [0, 1]$ of accepting bad news, i.e. of transmitting $\hat{m} = m_H$ conditional on $m = m_H$; this decision is made optimally conditional on Self 1's behavioral response; (ii) Self 1's consumption decision $c(\sigma, \hat{m})$ at date 1 conditional on the transmitted signal $\hat{m}$ and on Self 0's equilibrium strategy σ. All beliefs are derived according to Bayes' rule. Formally, σ is optimally chosen to satisfy

$$\sigma \in \arg\max_{t \in [0,1]} tV(x_H) + (1-t)V(\tilde{x}(\sigma)) - k(1-t) \tag{5}$$

whereas the consumption level $c(\sigma, \hat{m})$ following the transmitted signal $\hat{m}$ in this equilibrium is optimally chosen to satisfy

$$c(\sigma, m_H) = c^*(x_H) \text{ and } c(\sigma, m_L) = c^*(\tilde{x}(\sigma)), \text{ respectively.}$$

4 Results

4.1 Equilibrium behavior

Equation 5 shows that: (i) realism ($\sigma = 1$) is an equilibrium if and only if $V(\tilde{x}(1)) - V(x_H) \leq k$; ($ii$) denial ($\sigma = 0$) is an equilibrium if and only if $V(\tilde{x}(0)) -$

$V(x_H) \geq k$; (iii) any $\sigma \in (0, 1)$ that satisfies $V(\tilde{x}(\sigma)) - V(x_H) = k$ is an equilibrium strategy.

Equation 4 shows that the benefit $V(\tilde{x}(\sigma)) - V(x_H)$ of denial is nondecreasing with σ, the level of (habitual) realism, strictly so if the individual's consumption $c(\tilde{x}(\sigma))$ is positive. This observation shows the existence and uniqueness of the intra-personal equilibrium.

Proposition 1. *There exists a unique equilibrium of the game characterized by thresholds $0 < k_1 < k_2$ such that: (i) if $k \leq k_1$, the individual denies bad news ($\sigma = 0$); (ii) if $k \geq k_2$, the individual accepts bad news ($\sigma = 1$); (iii) if $k \in (k_1, k_2)$, σ is a strictly increasing function of k.*

In a population with heterogeneous costs of denial, individuals with the lowest k are thus the most likely to engage in self-deception. Consider for instance two individuals, 1 and 2, playing the cognitive strategies $\sigma = 1$ (realism) and $\sigma = 0$ (denial), respectively. Conditional on the message $m = m_H$, individual 1 forms a subjective expectation equal to x_H, and consumes a quantity $c^*(x_H)$, whereas individual 2 forms an expectation equal to $\tilde{x}(0) < x_H$ and consumes a quantity $c^*(\tilde{x}(0)) \geq c^*(x_H)$. In equilibrium, there is thus a negative association between people's subjective expectation of the level of the externality, and their consumption of meat.

4.2 Comparative statics

In this subsection we investigate how the parameters of the decision problem affect the individual's propensity to engage in self-deception, as characterized by her equilibrium strategy σ, and her resulting consumption decision.

4.2.1 Taste for meat

We start by analyzing the role of individuals' taste for meat in their cognitive choices. Our comparative statics analysis consists in comparing two individuals who only differ in the utility U that they derive from meat consumption. As a first step, suppose that, starting from the belief $\tilde{x}$ and the resulting consumption level $c(\tilde{x})$, the individual can marginally reduce the value of $\tilde{x}$ to $\tilde{x} - \epsilon$. By the envelope theorem, the marginal benefit derived from this change in belief equals $wc(\tilde{x})\epsilon$. This shows that the benefit from self-deception at any belief $\tilde{x}$ is proportional to the agent's consumption level $c(\tilde{x})$ at this belief. Proposition 2, proved formally in the Appendix, states that a higher taste for meat is associated with a lower level of

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realism: individuals who have a higher taste for meat are more likely to resort to self-deception. This effect further increases the difference between the (equilibrium) consumption levels of individuals who have heterogeneous preferences.

Proposition 2. *Individuals with the highest taste for meat are the most prone to self-deception. Suppose that the utility functions U_A and U_B satisfy $(U'_A)^{-1} \geq (U'_B)^{-1}$, which implies that, with identical beliefs, individual A consumes more than individual B. Then $\sigma_A \leq \sigma_B$.*

4.2.2 Price increase

In a standard model without self-deception, an increase in the price of meat directly decreases individuals' consumption. In this section, we show that the model of motivated reasoning also uniquely predicts that an increase in the price increases consumers' awareness of the moral consequences of their actions: the intuition is that a higher price lowers the agents' baseline consumption, making it less profitable to deny bad news in order to rationalize their behavior.

Let us index consumption by the price, and write $c(\tilde{x}, p)$ for the consumption level of the agent in a situation with price p and beliefs $\tilde{x}$. Suppose that the unit price of meat decreases marginally to $p - \epsilon$. By the envelope theorem, the marginal utility for the agent resulting from this price increase equals $wc(\tilde{x}, p)\epsilon$. The benefit from self-deception, $V(\tilde{x}(0)) - V(x_H)$, is therefore increased by a quantity $w[c(\tilde{x}(0), p) - c(x_H, p)]\epsilon$, which is nonnegative since $\tilde{x}(0) \leq x_H$: a marginal decrease in the price benefits relatively more to the agent in the scenario where she holds beliefs $\tilde{x}(0)$ than in the scenario where she holds beliefs x_H, as she consumes a higher quantity of meat in the former case. As a result, decreasing the price magnifies the returns to self-deception or, equivalently, the agent's level of realism increases with the unit price of meat. At the limit where $p \to +\infty$, the agent does not consume any meat irrespective of her beliefs, and therefore she has no incentives to deceive herself ($\sigma = 1$).

Proposition 3. *The individual becomes more realistic when the unit price of meat increases: σ is a nondecreasing function of p. In addition, there exists two thresholds p_1 and p_2 such that $\sigma(p) = 0$ if and only if $p \leq p_1$ and $\sigma(p) = 1$ if and only if $p \geq p_2$.*

In this model, an increase in the price therefore reduces consumption by two channels: a *direct* channel (for fixed beliefs), and an *indirect* channel (through the change in beliefs). The price elasticity of meat consumption is therefore larger than in a model with exogenous beliefs. To see this, consider the thresholds p_1 and p_2 defined in Proposition 3 (cf. Figure 3). In the region $[p_1, p_2]$ the individual plays

the mixed strategy $\sigma(p)$.[7] A first observation is that, if the price switches from p_1 to p_2, the individual's perception switches from $\tilde{x}(0)$ to x_H: her consumption response equals $c^*(x_H, p_2) - c^*(\tilde{x}(0), p_1)$, which we rewrite

$$\underbrace{c^*(x_H, p_2) - c^*(x_H, p_1)}_{\text{direct effect}} + \underbrace{c^*(x_H, p_1) - c^*(\tilde{x}(0), p_1)}_{\text{indirect effect}}.$$

Both effects are nonpositive: the indirect effect thus crowds in the standard decrease in consumption that follows from an increase in the price. The total variation is of a larger magnitude than the price response in a model without strategic denial.

Proposition 4. *The expected consumption is nonincreasing with p. In addition, there exist two thresholds $p_1 < p_2$ such that:*

1. *When $p \leq p_1$, $\sigma = 0$ and the individual's perception equals $\tilde{x}(0)$. The price elasticity of her demand is identical to a standard model with unit monetary price $p + \tilde{x}(0)$.*

2. *When $p \geq p_2$, $\sigma = 1$ and the individual's perception equals x_H. The price elasticity of her demand is identical to a standard model with unit monetary price $p + x_H$.*

3. *When $p \in [p_1, p_2]$, σ is an increasing function of p and the individual gradually incorporates moral concerns into her consumption choice. The (absolute) consumption response to a price variation is larger than in a model without denial.*

4.2.3   Moral concerns

We now turn to analyzing the effect of an increase in the parameter ω. This parameter can be interpreted as the individual's own feelings of guilt or empathy towards animals, or as the moral pressure imposed by social concerns on the individual's behavior. In the former case, our results speak to whether more altruistic individuals are more likely to form correct beliefs; in the latter case, our results speak to whether aggressive advertising campaigns (e.g., by animal rights activists) that aim at increasing the moral stigma are effective to reduce consumption.

In this paragraph, we show that the comparative statics in ω depends on the elasticity of the individual's demand. More precisely, we show that an increase in

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[7]Since σ is defined by the implicit equation $V(\tilde{x}(\sigma(p))) - V(x_H) = k$, the implicit function theorem shows that σ is a continuously differentiable function of p in that region.
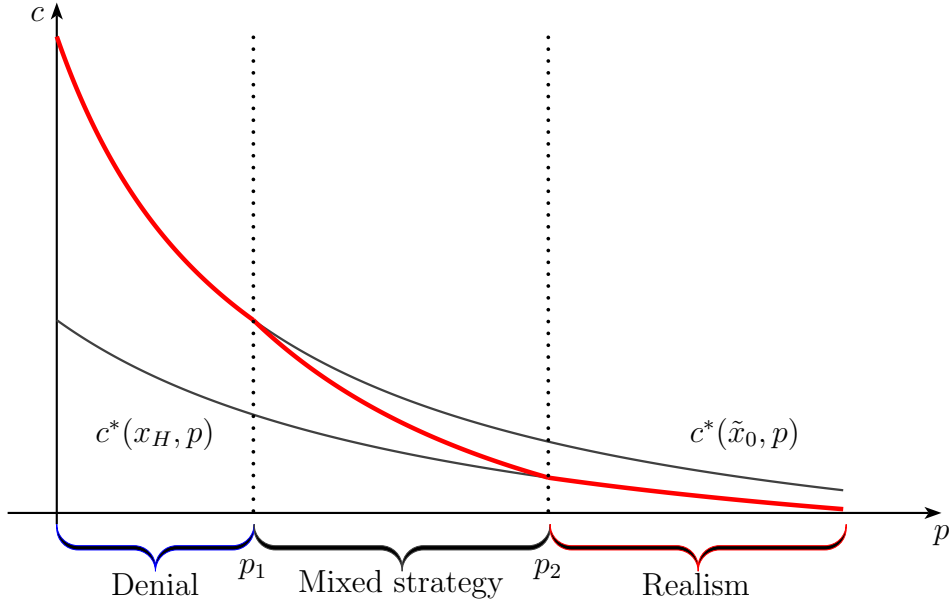
Figure 3 – Consumption c as a function of the price p

the moral cost associated with meat consumption makes individuals more realistic if and only if their consumption of meat is sufficiently elastic. Consumers with elastic demand are those willing to adapt their behavior to a change in the parameters (price and moral cost); when the moral cost associated with meat consumption increases, they react by lowering their consumption, e.g. by becoming vegetarians. In contrast, consumers with inelastic demand are unwilling to lower their consumption; as a consequence, following an increase in the perceived guilt, they are more likely to resort to motivated cognition in order to alleviate the psychological disutility associated with their behavior.

Formally, note that the the psychological benefit of playing the strategy $\sigma = 0$ (denying the externality) equals

$$\omega[x_H c^*(x_H) - \tilde{x}(0)c^*(\tilde{x}(0))].$$

Suppose first that $c^*(x_H) = 0$, for a given value of ω. The individual responds to an increase in her perception of the externality by becoming a vegetarian, which makes her insensitive to any moral pressure. In that case, an increase in ω reduces the benefit from rejecting bad news. Among the consumers who are (hypothetically) willing to become vegetarians if they adopt the signal $m = m_H$, an increase in the moral cost makes the individuals more prone to accept the evidence.

Suppose by contrast that $c^*(x_H) \sim c^*(\tilde{x}(0)) > 0$, meaning that the elasticity of demand is small. In that case, a marginal increase in ω does not trigger any

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behavioral response but magnifies the psychological cost incurred from meat consumption. Increasing ω therefore gives the individual larger incentives to deny the evidence and avoid thinking about the consequences of her consumption of meat. Among the consumers who have an inelastic demand for meat, those who are the most empathic towards animals are also the most likely to engage in wishful thinking and rationalize the evidence away.

To formalize this result, let

$$\epsilon_{U'}(c) = -\frac{cU''(c)}{U'(c) - p}$$

be the elasticity of the marginal utility of consumption (net of the unit price) with respect to the consumption level c. This preference parameter is inversely related ($\epsilon_{U'}(c) = 1/\epsilon_{c^*}(x)$ where $c^*(x) = c$) to the elasticity of consumption relative to the perception $\tilde{x}$, equal to

$$\epsilon_{c^*}(x) = -\frac{\tilde{x}(c^*)'(\tilde{x})}{c^*(\tilde{x})}.$$

Proposition 5. *Consider some $\omega \geq 0$, and the corresponding consumption level $c^*(x_H, \omega)$ under realism. If $c^*(x_H, \omega) = 0$, the individual becomes more realistic (i.e. σ is nondecreasing) when ω increases. If $c^*(x_H, \omega) > 0$, two cases arise:*

(i) Inelastic demand: if $\epsilon_{U'}(c) > 1$ for all $c > 0$, the individual becomes less realistic (i.e. σ is nonincreasing) when ω increases.

(ii) Elastic demand: if $\epsilon_{U'}(c) < 1$ for all $c > 0$, the individual becomes more realistic (i.e. σ is nondecreasing) when ω increases.

4.3 Attitude towards information

Finally, we turn to analyzing the individual's attitude towards information from the ex-ante perspective. We investigate the agent's binary decision of whether to acquire the signal or not.

We show in this section that an individual's attitude towards information depends on her equilibrium cognitive strategy σ: individuals are information-averse if and only if they engage in self-deception. Since incorrect updating is difficult to document empirically, whereas attitudes towards information are more easily elicited, motivated reasoning is often (indirectly) documenting by providing evidence of willful ignorance (Onwezen and van der Weele, 2016; Bell et al., 2017). Proposition 6 below shows that our model provides a possible foundation for information-avoiding behavior.

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For simplicity we focus on the two polar cases of complete realism ($\sigma = 1$) and complete denial ($\sigma = 0$). Suppose first that the parameters are such that the individual remains realistic in the unique equilibrium ($\sigma = 1$). Intuitively, there is no conflict of preferences between her two incarnations, who both would like to become better informed in order to make a correct decision. The individual benefits from receiving information, exactly as in a standard model. If the individual does not receive any information, she keeps her prior perception and her welfare equals $V(\tilde{x}(0))$. If, in contrast, she receives the signal, her posterior beliefs are equal to x_H with probability $1/2$ and $\tilde{x}(1)$ with probability $1/2$, and her expected welfare thus equals

$$\frac{1}{2}V(x_H) + \frac{1}{2}V(\tilde{x}(1)).$$

Her attitude towards information is therefore pinned down by the convexity of the indirect utility function V in the variable x. Since $V'(x) = -\omega c^*(x)$, V is convex in x, strictly so in the region where $c^*(x) > 0$. Realistic individuals are therefore information-loving, strictly so if their baseline consumption of meat absent information is positive.

Suppose now that the individual denies bad news ($\sigma = 0$). She forms the same perception equal to $\tilde{x}(0)$, whether she receives some information or not. However, if she receives the information she pays a cost of denial $k > 0$ with probability $1/2$. Intuitively, providing information is useless to the agent since it does not affect her consumption decisions, but it makes her psychologically worse-off due to the cost associated with rationalizing undesirable signals away.

Proposition 6. *Under realism (if $\sigma = 1$), the individual is information-loving. Under denial ($\sigma = 0$), the individual is strictly information-averse.*

4.4 Extension: consumption externalities

We have so far considered the case of a single agent. To analyze the inter-dependencies between the cognitive strategies and the consumption decisions of different individuals, we now introduce consumption externalities in the model. We assume that individuals' psychological utility is negatively affected not only by their own consumption of meat but also by the aggregate consumption, reflecting the idea that they genuinely care about the welfare of animals, irrespective of whether or not they are responsible for the suffering inflicted. The main result from this section is that individuals' cognitive choices are strategic complements, as in Bénabou (2013), which gives rise to the coexistence of two equilibria: one "realistic" equilibrium where individuals form correct beliefs and consume small amounts, and one "denial"

equilibrium where individuals perceive a lower externality than the actual one, and consume large amounts.

We assume that the economy is composed of $n + 1$ agents who have identical preference parameters (U, ω, k) and receive a common signal m at date 0, generated as explained in Section 3. The presence of other individuals modifies the analysis of the individual decision problem in two ways. First, we assume common knowledge of rationality. Therefore, at date 2, the individual observes the consumption decisions of her peers, and revises her beliefs about X according to this observation, as the behavior of other individuals might reveal some information about m that the agent has repressed. Importantly, we assume that the agent cannot distort her beliefs about X again if she receives an informative signal, reflecting the idea that the choices of other agents are observed regularly and are more difficult to rationalize away than the original signal.

Second, the individual is directly harmed by others' consumption of meat. This specification is in line with the interpretation of the model in which individuals have empathic feelings towards animals irrespective of whether the harm is caused by their own or someone else's decisions. Agent i's utility if she forms an expectation equal to $\tilde{x}_i$ now equals

$$\tilde{V}(c, \tilde{x}_i) = U(c_i) - pc_i - \omega\tilde{x}_i c_i - \xi\tilde{x}_i \sum_{j \neq i} c_j. \tag{6}$$

The parameter ω still represents the cost of guilt caused by the individual's own consumption. The parameter ξ measures the agent's altruism towards animals, and describes the extent to which she internalizes the aggregate externality caused by collective decisions.

The timing of the model is as follows. At date 0, all individuals (simultaneously) choose how to process the common signal. At date 1, they form their recollection, update their beliefs, and (simultaneously) make their consumption decisions. At date 2, they observe their peers' consumption decisions, revise their beliefs about X, and receive the utility level given by Equation 6.

For simplicity, we focus on symmetric equilibria in which all individuals play a pure cognitive strategy (either $\sigma = 0$ or $\sigma = 1$), and we assume that the parameters of the model are such that $c^*(\tilde{x}(0)) > 0$, meaning that consumption of meat is positive if individuals stay with their prior beliefs.

Collective realism   Let us first study the conditions under which collective realism is an equilibrium. Suppose first that all agents remain realistic and consume

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$c^*(x_H)$ conditional on the message $m = m_H$. If agent i accepts the evidence $m = m_H$ she receives the utility $V(x_H) - \xi n x_H c^*(x_H)$, where V is defined in Equation 3. In contrast, if she denies the evidence and encodes $m = m_L$, she perceives an externality equal to $\tilde{x}(1)$ and thus consumes $c^*(\tilde{x}(1))$. But once she observes the behavior of her peers, who consume $c^*(x_H) < c^*(\tilde{x}(1))$,[8] she infers that the externality is high and that she has deceived herself into denying the evidence. She then pays a large moral cost for her suboptimally large consumption. Overall, she receives the utility

$$(c^*(\tilde{x}(1))) - (p + \omega x_H)c^*(\tilde{x}(1)) - \xi n x_H c^*(x_H) < V(x_H) - \xi n x_H c^*(x_H)$$

Realism is therefore a symmetric equilibrium strategy for any $k \geq 0$. In this equilibrium, the incentives to rationalize the evidence away are limited since observing others consuming small quantities makes it impossible for the individual to ignore the externality generated by meat consumption. All in all, the presence of other realistic agents therefore gives the individual higher incentives to accept the evidence.

Collective denial Consider now a candidate equilibrium where all individuals deny the evidence and thus consume $c^*(\tilde{x}(0))$. If agent i deviates and accepts the evidence $m = m_H$, she receives the utility $V(x_H) - \xi n x_H c^*(\tilde{x}(0))$. If she plays the equilibrium strategy $\sigma = 0$, she forms the perception $\tilde{x}(0)$ and observes that all other agents consume $c^*(\tilde{x}(0))$: hence, she does not revise her beliefs about m, knowing that others have deceived themselves as well, and she receives the utility $V(\tilde{x}(0)) - \xi n \tilde{x}(0) c^*(\tilde{x}(0))$. Since all players deny the evidence, their consumption decisions are not informative about the original public message, which increases the scope for self-deception. Denial is an equilibrium strategy if and only if

$$V(\tilde{x}(0)) - V(x_H) + \xi n [x_H - \tilde{x}(0)] c^*(\tilde{x}(0)) \geq k \tag{7}$$

The left-hand side of Equation 7 is increasing in n. Intuitively, the presence of other agents who consume a positive amount of meat $c^*(\tilde{x}(0))$ creates a psychological cost for any individual; as a result, the larger the aggregate consumption $n c^*(\tilde{x}(0))$, the larger the individual incentives to downplay the magnitude of the externality. The existence of deniers thus further encourages denial. As a consequence, the cognitive strategies of different individuals are strategic complements, and multiple equilibria might co-exist.

Proposition 7. *Suppose that $c^*(\tilde{x}(0)) > 0$. Then collective realism ($\sigma = 1$) is an*

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[8]Indeed, the assumption $c^*(\tilde{x}(0)) > 0$ implies that $c^*(\tilde{x}(1)) > c^*(\tilde{x}(0)) > c^*(x_H)$.

equilibrium. In addition, there exists $n_0 \in \mathbb{N}$ such that, for all $n \geq n_0$, collective denial ($\sigma = 0$) is also an equilibrium.

5 Discussion

We conclude by discussing the model and delineating some avenues for future research.

Demand for animal welfare   Our model is based on the assumption that individuals factor in ethical concerns in their meat consumption decisions. The evidence about the role of ethical concerns appears to be contradictory. On the one hand, animal-friendly products only represent a small market share. On the other hand, some experiments or surveys on consumers' willingness-to-pay for animal welfare identify that many individuals are willing to pay a premium for animal welfare that is higher than the cost premium. This result is not restricted to hypothetical choices but also survives, to a large extent, to the introduction of real incentives. For instance, in the experiment by Albrecht et al. (2017), 37% of subjects are willing to pay 25 euros or more to put a living hen into better conditions (organic farming) than intensive farming facilities, and the average willingness-to-pay equals 14 euros. Consumers also express a concern for animal welfare in the voting booth: As an illustration, in 2008 Californian voters accepted with a large majority (63.5% of ballots) a proposition meant to reduce the confinement of farm animals.[9] This observation might seem surprising, as the conventional products that the law bans (battery cages, veal crates, gestation crates, etc.) largely dominated the Californian market at the time of the referendum. As Norwood and Lusk (2011) put it in their "California egg paradox": "Why are consumers seemingly so compassionate in the voting booth and yet so indifferent in the grocery store?"

These findings point to the difficulty of retrieving the importance of moral concerns from people's consumption, as their decisions seem inconsistent across decision problems. One hypothesis that could explain these observations is that the salience of the moral consequences of one's choices is not the same in the grocery store, in the lab, and in the voting booth: The low salience of animal welfare in the grocery store might help consumers divert their own attention away from the moral aspect of their decisions at little psychological cost, while the high salience of animal welfare

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[9]This "Proposition 2" stated: "a person shall not tether or confine any covered animal, on a farm, for all or the majority of any day, in a manner that prevents such animal from: a) Lying down, standing up, and fully extending his or her limbs; and b) Turning around freely." Similar laws were voted in several states in the US.

concerns in lab experiments and in the referendum mentioned above might make it more difficult to engage in self-deception.[10] This can be understood through the lens of our model if the cost k of self-deception is allowed to be context-dependent. Alternatively, individuals might view animal welfare as a public good and might be reluctant to provide it privately (as consumers) but willing to vote for policies that regulate the externality, as in a standard public-good model. The private demand for animal welfare reported in lab experiments could then be driven by experimenter demand effects or social desirability biases. In any case, further research should try to provide a resolution of the above puzzle by carefully exploring the determinants of people's consumption decisions.

Information supply   Our model focuses on the demand side of information and belief formation by assuming that the signal received by the decision-maker is exogenous. In practice, this information is often provided by interest groups that face incentives to try manipulating consumers' beliefs.

On one side of the spectrum, the meat sector has strong incentives to lobby against information provision, or to obfuscate the information received by consumers. Some existing laws in the US, such as the Animal Enterprise Terrorism Act (AETA), which criminalizes the release of images and videos in the farming industry on the grounds of violation of private property, are sometimes accused of being primarily motivated by a desire to hide the reality of farming practices from consumers.[11] Our model shows that this supply-side strategy is actually complemented, on the demand side, by the behavior of deniers, who do not have any incentives to acquire information about animal farming (Proposition 6). This contrasts with a standard communication game (e.g., cheap talk) where both parties have conflicting interests.

On the other side of the spectrum, groups of animal activists have the opposite interests, as they would benefit from informing the population about the objective realities of animal farming. Interestingly, these groups often attempt to directly influence consumers' attitudes through "shock" information campaigns centered on emotionally disturbing content (e.g., comparisons between meat products

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[10]Interestingly, Norwood and Lusk (2011) document that the demand for free-range eggs has increased by 180% in California during the ballot period, suggesting a potential effect of the political debate on consumers' demand.

[11]For instance, the New York times (New York Times, 2013) interprets such "aggag" laws (i.e., antiwhistle blower laws in the agricultural industry) as follows: "The socalled 'aggag' laws now being considered by several states, including California, Illinois and Indiana, have nothing to do with protecting property. Their only purpose is to keep consumers in the dark, to make sure we know as little as possible about the grim details of factory farming. These bills are pushed by intensive lobbying from agribusiness corporations and animal production groups."

and human bodies) rather than on statistical information about the meat industry. Nevertheless, these tactics seem to have had limited success so far. One possible hypothesis, consistent with our model, is that these information campaigns target the parameter ω of our model and seek to increase the guilt induced by meat consumption. As shown in Proposition 5, this strategy might be efficient for some consumer types (those with elastic preferences) but inefficient or even counter-productive for others (those with inelastic preferences). More generally, understanding the effects of activists' and lobbyists' communication strategies when consumers are prone to self-deception is an important topic, that we leave for future research.

Appendix: Proofs

Proof of Proposition 1 Define $k_1 = V(\tilde{x}(0)) - V(x_H)$ and $k_2 = V(\tilde{x}(1)) - V(x_H)$. Both k_1 and k_2 are nonnegative. The function $\sigma \to V(\tilde{x}(\sigma)) - V(x_H)$ is nondecreasing in σ and maps $[0, 1]$ into $[k_1, k_2]$. Three cases arise:

(i) If $k_2 \leq k$, $\sigma = 1$ is an equilibrium, uniquely so if $k_2 < k$.

(ii) If $k_1 \geq k$, $\sigma = 0$ is an equilibrium, uniquely so if $k_1 > k$.

(iii) If $k \in [k_1, k_2]$, the intermediate value theorem applies since the function $V \circ \tilde{x}$ is continuous, and therefore there exists some $\sigma \in [0, 1]$ such that $V(\tilde{x}(\sigma)) - V(x_H) = k$.

To prove the uniqueness, suppose that $\sigma_1 < \sigma_2$ are both equilibrium solutions. This implies that

$$V(\tilde{x}(\sigma_1)) \geq V(\tilde{x}(\sigma_2)). \tag{8}$$

Indeed, $\sigma_2 > 0$ implies that $V(\tilde{x}(\sigma_2)) - V(x_H) \leq k$, whereas $\sigma_1 < 1$ implies that $V(\tilde{x}(\sigma_1)) - V(x_H) \geq k$.

Since $V \circ \tilde{x}$ is strictly increasing on the range of σ that delivers positive consumption levels $c^*(\tilde{x}(\sigma))$, Equation 8 is possible only if $c^*(\tilde{x}(\sigma_1)) = c^*(\tilde{x}(\sigma_2)) = 0$. As a consequence, the monotonicity of c^* implies that $c^*(x_H) = 0$, and therefore $V(\tilde{x}(\sigma_i)) - V(x_H) = 0 < k$ for $i = 1, 2$. This contradicts $V(\tilde{x}(\sigma_1)) - V(x_H) \geq k$. $\square$

Proof of Proposition 2 Let $c_A(\tilde{x}) = \max\left[(U_A')^{-1}(p + w\tilde{x}), 0\right]$ and c_B be defined similarly. Let σ_A be agent A's equilibrium strategy. At this equilibrium level, agent A's benefit from self-deception equals $V_A(\tilde{x}(\sigma_A)) - V_A(x_H)$. The crucial step in the proof is to show that

$$V_B(\tilde{x}(\sigma_A)) - V_B(x_H) \leq V_A(\tilde{x}(\sigma_A)) - V_A(x_H). \tag{9}$$

Once this is established, the result $\sigma_B \geq \sigma_A$ follows immediately from the analysis of the intra-personal equilibrium in Proposition 1.

Note that for inequality 9 to hold, a sufficient condition is that the function $x \to V_B(\tilde{x}) - V_A(\tilde{x})$ is nondecreasing in $\tilde{x}$, since $\tilde{x}(\sigma_A) \leq x_H$. But, by the envelope theorem,

$$\frac{\partial V_A(\tilde{x})}{\partial \tilde{x}} = -\omega c_A(\tilde{x})$$

and, similarly,

$$\frac{\partial V_B(\tilde{x})}{\partial \tilde{x}} = -\omega c_B(\tilde{x}).$$

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As a consequence,

$$\frac{\partial[V_B(\tilde{x}) - V_A(\tilde{x})]}{\partial \tilde{x}} = \omega[c_A(\tilde{x}) - c_B(\tilde{x})] \geq 0.$$

$\square$

Proof of Proposition 3 Consider a price level p and the resulting equilibrium cognitive strategy σ. Let us write the indirect utility function as a function $V(\tilde{x}, p)$ of beliefs and price. At this equilibrium, the agent's benefit from self-deception equals $V(\tilde{x}(\sigma), p) - V(x_H, p)$. By the envelope theorem,

$$\frac{\partial[V(\tilde{x}(\sigma), p) - V(x_H, p)]}{\partial p} = c(x_H, p) - c(\tilde{x}(\sigma), p) \leq 0$$

and thus the net benefit from self-deception is nonincreasing with the price: this observation, together with the analysis of the intra-personal equilibrium in Proposition 1, proves the result. $\square$

Proof of Proposition 5 Let us write the indirect utility function as a function $V(\tilde{x}, \omega)$ of beliefs and ω. Applying the envelop theorem yields

$$\frac{\partial[V(\tilde{x}(\sigma), \omega) - V(x_H, \omega)])}{\partial \omega} = -\tilde{x}(\sigma)c^*(\tilde{x}(\sigma), \omega) + x_H c^*(x_H, \omega). \qquad (10)$$

If $c^*(x_H, \omega) = 0$, this expression is nonpositive, therefore σ is nondecreasing in ω.

Suppose otherwise that $c^*(x_H, \omega) > 0$, which implies that for all $\tilde{x} \leq x_H$, $c^*(\tilde{x}, \omega) = (U')^{-1}(p + \omega\tilde{x})$. If the function $\tilde{x} \to \tilde{x}c^*(\tilde{x}, \omega)$ defined on $[x_L, x_H]$ is strictly increasing, expression 10 is nonnegative and therefore σ is nonincreasing in ω. This is true if

$$-\frac{\tilde{x}(c^*)'(\tilde{x}, \omega)}{c^*(\tilde{x}, \omega)} < 1 \Leftrightarrow -\frac{\omega\tilde{x}}{U''[(U')^{-1}(p + \omega\tilde{x})](U')^{-1}(p + \omega\tilde{x})} < 1$$

$$\Leftrightarrow -\frac{U''[(U')^{-1}(p + \omega\tilde{x})](U')^{-1}(p + \omega\tilde{x})}{\omega\tilde{x}} > 1$$

$$\Leftrightarrow \epsilon_{U'}[(U')^{-1}(p + \omega\tilde{x})] > 1.$$

The case $\epsilon_{U'}(c) < 1$ is symmetric. $\square$

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Supplementary Appendix to "An economic model of the meat paradox"

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This supplementary appendix shows that the theory makes analogous predictions if motivated belief formation is represented using the cognitive dissonance model of Brunnermeier and Parker (2005), instead of the memory management model considered in the paper.

Let the indirect utility be defined as follows:

$$
\begin{aligned}
V(\tilde{x}) &= \max_{c \geq 0} U(c) - pc - \omega \tilde{x} c \\
&= U(c^*(\tilde{x})) - pc^*(\tilde{x}) - \omega \tilde{x} c^*(\tilde{x}).
\end{aligned}
$$

Let $\tilde{x}(t) = t x_H + (1-t) x_L$ be the subjective expectation about animal suffering. Suppose now that the consumer observes that the level of animal suffering is x_H. Following Brunnermeier and Parker (2005), the beliefs' choice problem can now be written as follows:

$$
\max_{t \in [0,1]} (1-k) V(\tilde{x}(t)) + k[U(c^*(\tilde{x}(t))) - pc(\tilde{x}(t)) - \omega x_H c^*(\tilde{x}(t))]. \tag{11}
$$

This model describes a "compromise" between maximizing the subjective welfare $V(.)$ and maximizing the "objective" welfare as represented by the term into brackets $[U(c^*(\tilde{x}(t))) - pc^*(\tilde{x}(t)) - \omega x_H c^*(\tilde{x}(t))]$. This last term is coined objective welfare because it accounts for the observed level of animal suffering x_H and is maximized for beliefs $t = 1$. Hence by choosing $t < 1$ the agent incurs a welfare loss. In other words, the cost of denying reality is the reduction in objective welfare associated with a suboptimal consumption decision (i.e., too much meat consumption $c^*(\tilde{x}(t)) \geq c^*(x_H)$).

The parameter $k \in [0,1]$ is the weight given to the objective welfare. Note that model (11) can also be rewritten as

$$
\max_{t \in [0,1]} V(\tilde{x}(t)) - k\omega c^*(\tilde{x}(t))(x_H - x_L)[1-t]. \tag{12}
$$

Hence, the choice of optimal beliefs may be viewed as a trade off between the subjective welfare $V(x)$ and a cost of self-deception captured by the term $k\omega c^*(\tilde{x}(t))(x_H - x_L)[1-t]$. This last term increases with the extent of self-deception $1-t$. Note that this term also increases with consumption $c^*(\tilde{x}(t))$ and the parameter k. Hence, the

parameter k can be interpreted as the (per consumption) unit cost of self-deception, analogously to the model considered in the main text.

Differentiating (12) with respect to t we get

$$- (1 - k)\omega c^*(\tilde{x}(t))(x_H - x_L) - k\omega(c^*)'(\tilde{x}(t))(x_H - x_L)^2[1 - t]. \qquad (13)$$

Note that the first term is negative while the second term is positive under $t < 1$ given $(c^*)'(.) \leq 0$. In particular, when k is large enough then the second term always dominates, and the maximum must be $t = 1$. Conversely, when k is low enough then the first term always dominates and the maximum must be $t = 0$. Moreover, when an interior solution exists, then the optimal t increases in k since (13) increases in k. As a result, we retrieve a similar characterization of optimal beliefs as in Proposition 1. Moreover, the relationship between optimal consumption and the unit cost of self deception has also a similar form.[12] In words, less meat consumption is associated with more realism about animal suffering.

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[12]Take for instance $p = \omega = x_H = 1$, $x_L = 0$ and $U(c) = \log c$. Then optimal beliefs are equal to $t = \max(0, 2k - 1)$ so that optimal consumption is equal to $c^*(\tilde{x}(t)) = \min(1, 1/(2k))$ for $k \in [0, 1]$.