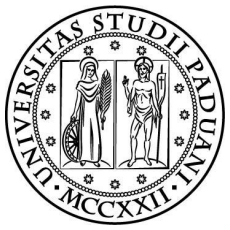

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FOOD CHOICES: THE HIDDEN COSTS OF ANIMAL AGRICULTURE AND DERIVATIVES CONSUMPTION

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Abstract

Gli ultimi anni hanno visto lo sviluppo di un fervente dibattito riguardante il benessere degli animali da reddito confinati negli allevamenti intensivi. Tale dibattito include necessariamente questioni legate alla scelta del regime alimentare che vengono, molto spesso, analizzate in modo ideologico, secondo concetti di "giusto" e "sbagliato", finendo per condannare la questione ad un'inevitabile immobilità dovuta allo scontro di diverse filosofie e moralità dei partecipanti. Questo lavoro si propone di contribuire a superare tale impasse adottando un approccio economico, guardando ai partecipanti nel loro ruolo di consumatori, analizzando le loro scelte e valutandone le conseguenze in termini di efficienza allocativa. Il presente lavoro analizza specificatamente il caso americano, poiché possiede alcune caratteristiche peculiari relative al consumo e alla produzione di prodotti animali che lo rendono particolarmente esplicativo delle esternalità economiche negative derivanti da tali attività.

Il primo capitolo offre una panoramica delle dinamiche di domanda e offerta di prodotti animali negli Stati Uniti, inclusa la loro evoluzione e le conseguenze della commistione statale nel mercato, inducendo il lettore a riflettere sulla possibile preponderanza dell'offerta nella formazione delle preferenze da parte dei consumatori americani e sulle conseguenze sul consumatore e sulla società sotto forma di esternalità.

Il secondo capitolo seleziona alcune tra le più marcate esternalità cosiddette "fisiche", ovvero ad impatto tangibile sulle risorse ambientali, proseguendo con un tentativo di monetizzazione di tale impatto e proponendo possibili corsi di azione a livello di policy che possano ovviare all'inefficienza allocativa incorporando tali costi nei prezzi finali.

Il terzo capitolo si occupa delle esternalità cosiddette "psicologiche", ovvero ad impatto diretto sulle persone, misurate attraverso la disponibilità di pagare dei consumatori americani per un superiore livello di benessere per gli animali da reddito. Quando tale disponibilità a pagare viene inibita, non trovando espressione sul mercato americano, situazione i cui motivi vengono discussi nel capitolo, viene utilizzata dagli economisti come buona approssimazione delle esternalità negative imposte dallo specifico settore alimentare sulla società. Il capitolo si dipana, successivamente, traslando in termini monetari tali esternalità e discutendo potenziali misure correttive, le relative conseguenze su domanda e offerta e le difficoltà di implementazione.

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Introduction

In the brewing controversy which is now the animal welfare debate what's usually missing is an objective approach which would give an overview without dealing with concepts of "right" and "wrong" (that is where we are at an impasse because of the variety of philosophies or moralities of the people involved) and provide a sound and logical basis to define the outcome of farm animal welfare policies. Economists don't "describe the world as any one of us might want it to be, or fear it is, or pray that it becomes but rather to explain what it actually is" (Levitt & Dubner, 2009) and what might happen if a certain course of action is taken according to people's views which are treated as mere preferences.

Since people are consumers what we might be interested in is to analyse consumption trends to begin with and to understand if consumption of animal derived goods is actually demand or supply driven.

The first chapter of this work gives an overview on the dynamics within animal-based products marketplace in the U.S., chosen as case study mostly because of magnitude in production and consumption levels, and offers a taxonomy of the related negative externalities. Because livestock production imposes negative externalities on society, with higher levels of production and consumption such externalities are bigger as well, making the American case so illustrative.

The second part of this work deals with some of the so-called "physical" externalities, which impact environmental resources directly, describing the damage mechanism and attempting to translate cost estimates in monetary terms.

The last part focuses on the so-called "psychological" externalities, affecting humans directly and measured by their willingness to pay for improved standards in animal industry. When, under some conditions, consumers' willingness to pay cannot be fully expressed through purchase decisions, it represents the foregone benefits people face, and it's therefore used by economists as a monetary approximation of the externalities involved. The third chapter unravels by providing monetary terms for such costs and discussing potential corrective measures within policy framework, their consequences on demand and supply levels and implementation related challenges.

Chapter 1

Livestock in perspective

What now, in light of the vivid animal welfare debate taking place, may appear as a complex relationship between humans and animals, has actually begun a long time ago, likely in different ways and at different centres of origin. Rudimentary farming evolved from the discovery made by some Neolithic hunter-gatherer societies, when people noticed that the seeds brought back to the cave would start to grow close to the spot they were stored in and in refuse piles, from food that had not been digested. Human pattern recognition abilities led our ancestors to put to use the non-random appearance of plants in order to domesticate them.

Something similar may have happened with wild animals: instead of moving around, hunting, the most thoughtful clan members may have realized that it would be easier to block some animals in a space with no exit to make them available for future hunts. The process of domestication, defined as "the genetic alteration of a plant or animal caused by human decisions over which offspring are permitted to reproduce" (Norwood & Lusk, 2011), then followed. As noted by Clutton-Brock (Norwood & Lusk, 2011) agricultural societies prevailed over hunter-gatherer societies when, for a variety of reasons, people moved to live more closely over time, creating a number of densely populated areas which made it difficult for hunter-gatherers to thrive: in order to be successful these clans needed larger amounts of land per person and such proximity made it necessary to extract greater amount of nutrition from each acre of land.

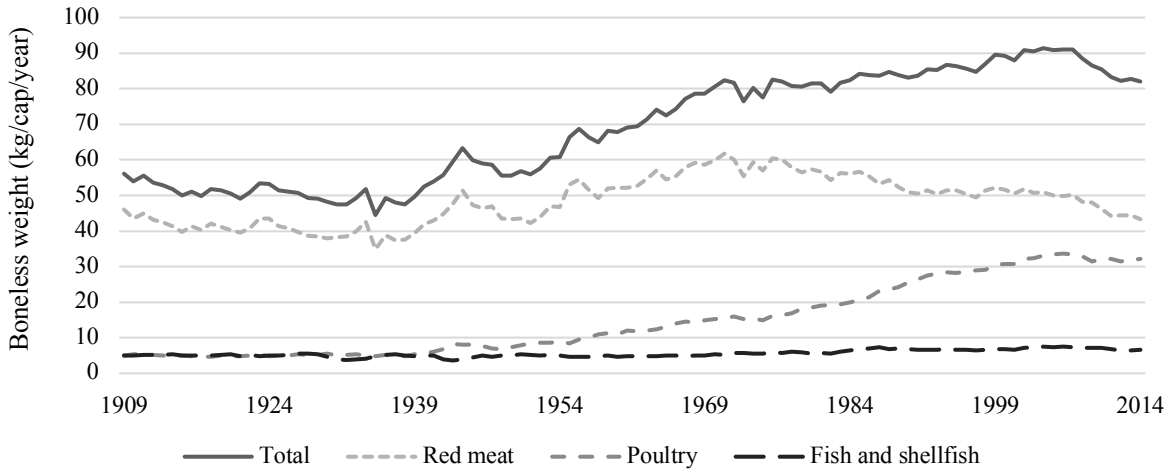
For the past 10,000 years the vast majority of humans lived and worked on some sort of farm. Nowadays, as of 2012 United States Department of Agriculture (USDA) data, hired farmworkers make up for less then 1% of all U.S. wage and salary workers. Of these, employees in livestock account for 44% (USDA, 2016). The evidence that so few are productive enough to feed so many can be found entering any grocery store. If such empirical approach wasn't enough some more data can be useful: for instance, in the period between 1957 and 2007, although the demand for dairy products grew by 40%, the number of related farms plunged from 2.9 million to 65,000 (USDA, 2010). The number of hog farms shrank by 76% from 1982 to 2002 even if pork production grew by 10% during the same period (Starmer & Wise, 2007). It goes without saying that, in order to satisfy the increased demand, the output per unit of input must have risen: in other words farmers became more productive. This efficiency improvement is tightly linked to the fact that, for starters, the bucolic image of the farm people usually like to picture should be forgotten: today, the vast majority (Food & Water Watch, 2015) of U.S. farm animals live in steel and concrete factories in conditions so poor they make it impossible to engage in natural behaviours and, in many cases, actually cause physical and psychological

suffering. This is just one of the trade-offs steaming from the increased efficiency which cause the externalised costs offloaded by livestock rearing on American society to be impressively huge.

1.1 Demand and supply trends in the United States

In the last fifty years the cost to be elected to U.S. office has risen tenfold (in inflation adjusted dollars) (Ansolabehere et al., 2003). In the last century the consumption of meat (red meat, poultry and fish) across U.S. notably increased, nearly doubling between 1909 (56.2 kg/cap/year) and 2006 (91 kg/cap/year) (USDA, 2016). The slight decrease following from this point on is due to a drop in red meat consumption which, on average, accounts for 70% of the total (see Figure 1.1).

Figure 1.1 Total red meat, poultry and fish consumption in the United States

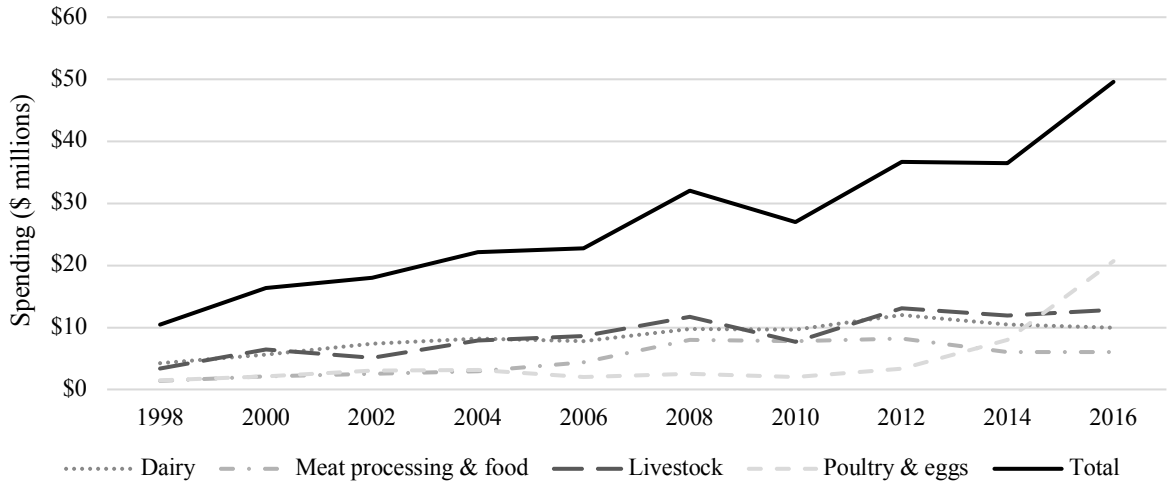


Source: USDA (2016)

These trends may appear like totally unrelated but guess again: as the cost to get elected increased, so did the amount of money to influence the ones in Congress (Simon, 2013). Those involved in agribusiness industry, specifically in sectors such as dairy, meat processing and food and livestock (poultry and egg included) have boosted their spending by 275% and 535% on lobbying (between 1998 and 2016) and campaign contributions (between 1990 and 2016) respectively, in inflation adjusted dollars (Center for Responsive Politics, 2017). The cumulative spending is illustrated in Figure 1.2. The amount spent on lobbying and campaign contributions for every mentioned sector was added and, since campaign contributions data are

only available from 1998, biennially, the years included are the ones for which both data are accessible.

Figure 1.2 Total spending in lobbying and campaign contributions in the U.S. (1998 to 2016)



Source: Center for Responsive Politics (2017)

One study found that a $1 industry donation from Political Action Commitees (which accounts, on average, for the 31% of the total contributions plotted above) during campaign usually yields a $2,000 return in subsidies (Lopez, 2001). USDA was expected to spend $38 billion in 2016 supporting US farmers (USDA, 2016). In 2009, state and local governments contributed $24.7 billion (Grey, Clark, Shih and Associates Limited, 2010), which, if we assume that expense levels are not subject to great variability, are $27.6 billion in 2016 inflation adjusted dollars, for a total of $65.6 billion to all segments of U.S. agriculture. A study by Physicians Committee for Responsible Medicine (Simon, 2013) shows that 63% of all U.S. agricultural subsidies benefit animal food producers: applying this percentage to the $65.6 billion, even without adding fish subsidies, we get an estimated total of $41.3 billion in subsidies to animal food producers all over U.S. This estimate includes both subsidies to livestock producers and crop producers (intensively bought by the former to be used as feed ingredients). Since feeding expenses account for almost half the cost of raising hogs and nearly 2/3 the costs of producing poultry and eggs (Wise, 2005), Starmer and Wise (2007) estimated that crop subsidies allowed factory farms to lower their operating costs by 15% from 1997 to 2005, saving roughly $35 billion over the period.

From a microeconomic point of view, subsidies represent a distortion in the normal market forces of supply and demand. A subsidy will usually shift the supply curve rightwards, lowering the market price of the subsidized commodity. Subsidies can reduce market prices to levels

below the cost of production: this was the case of corn which, from 1986 to 2005, was more costly to grow than it was worth in market based value in every year but one (Egan, 2000). This situation triggered a vicious cycle because the excess of supply caused by subsidies led to a fall in market prices which, in turn, induced (subsidised) farmers to grow even more corn in order to make up for the income shortfall and lowering the market prices, again: the subsidies tripled during the second half of that period but farmers' net income fell by 15% (Wise, 2005).

Such subsidies promote the growth of factory farms, also known as concentrated animal feeding operations (CAFOs). As reported by Grunwald (2007) CAFOs tend to depress local regions with pollution-related costs and they don't even compensate by providing jobs (hiring fewer workers per animal than smaller farms do); by generating larger revenues CAFOs don't generate higher tax revenues: a study by Kliebenstein (1998) analysing state and local tax revenue from swine farms concluded that CAFOs generate the least tax revenue per pig.

Finally, crop subsidies favours big players over small farmers (because the latter usually feed livestock with corn and soybeans of their own production), driving some of them from the rural landscape (Grunwald, 2007). Farm support policies were enacted to provide financial assistance to struggling farmers during and after the Great Depression. Henry Wallace, the Secretary of Agriculture in the period between 1933 and 1940, claimed that the farm subsidies were "a temporary solution to deal with an emergency" (Norwood & Lusk, 2011). Now the average farm household income exceeds that of the average US household and there are many fewer farmers, still farm policies persist (Norwood & Lusk, 2011).

These subsidies are part of the explanation behind the price fall of meat and dairy products from 1980 to 2008 (more detailed data will follow): producers certainly have made animal agricultural practices more efficient, but it would be naïve to attribute the decrease in animal food prices only to these gains. Moreover, considering the externalities related costs that will be soon discussed, by idolizing technology improvements alone we would miss a bigger picture for a silver lining.

Besides prices kept artificially low by subsidies something else may be boosting Americans' demand for animal foods. In the United States government uses the so-called commodity checkoff programs: they work by collecting funds through a checkoff mechanism (usually by placing a small assessment on the wholesale price) and using them to promote and make research on the commodity, building up its market position. These operations are authorized by Congress and overseen by USDA and some of the major ones are dedicated to animal derived food producers, having a "return on investment [which] can range as high as

$18" (Shipman, 2011) and raising sales by $5 per checkoff dollar spent for beef, by $14 for pork and $38 for lamb (USDA Agricultural Marketing Service, 2011).

Table 1.1 shows return on investment for other food items as well. In the dairy industry these programs contributed to more than 7 billion additional pounds of milk sold over 2011-2012 (Dairy Management, Inc., 2011). Adding all up, checkoff programs provided funding of $557 million yearly for animal food producers to boost their sales (Becker, 2007).

Table 1.1 Effects of checkoff spending on animal food sales

Checkoff program	Annual checkoff funds invested (millions $)	ROI (per checkoff dollar)	Extra sales (millions $)
Pork	65.4	14	915.6
Beef	79.8	5	399.0
Eggs	21.0	6	126.0
Lamb	2.3	38	87.4
Milk	107.8	8	862.4
Dairy	281.2	8	2,249.6
Total	557.5		4,640.0

Source: USDA Agricultural Marketing Service (2011)

The total economic stimulus is even bigger if we consider the multiplier effect due to the fact that increase in sales leads to new jobs and in turn, to more spending. Curtis Braschler et al. (Simon, 2013) came up with a multiplying factor of 0.77 to grasp the effect of an increase in jobs or income on farm communities: applying it to the sales total would bring the number to $8.2 billion.

What's important to highlight is that such efforts are nothing like conventional advertising, where private firms commit to convince us their products are better by forking out their own funds: they are designed to boost the sales of every unit of the given commodity, therefore increasing the overall demand for the covered goods.

The problem is not about hoping up the demand itself. Even leaving out of the picture the externalities which animal-based production and consumption offload on consumers and society as a whole, Americans already consume too much of these products.

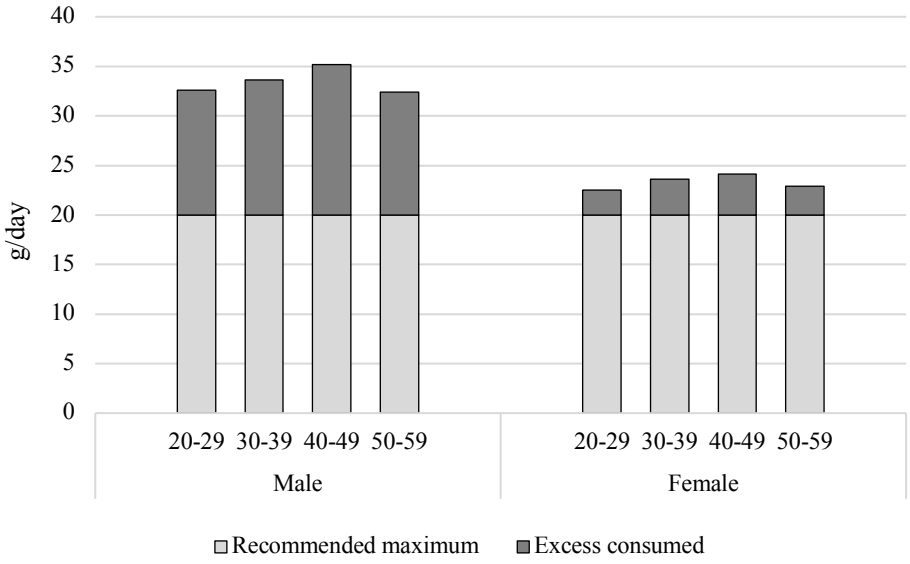
While overseeing checkoff programs, the US Department of Agriculture also partners with the US Department of Health and Human Services to release *Dietary Guidelines for Americans* every five years. Some argue that the nutritional advices it contains are based more on marketing than science by just looking at the membership of its drafting group. Herman (Simon, 2013) analysed its composition and found out 9 out of 13 panelists of the latest (as of 2010) Dietary Guidelines Advisory Committee were linked to industry, having served as advisors or consultants to corporations such as Dannon, McDonald's, Kellogg's, Tropicana, General Mills and others.

This might give a clue on why the Harvard School of Public Health dismisses the USDA guidelines as the product of "intense lobbying effort from a variety of food industries", defining its recommendations as "flawed result of the tense interplay of science and the powerful food industry". Simon (2013) reported how, when advising against consumption of animal foods, *Dietary Guidelines* choses a vague and technical terminology, avoiding terms like "beef" and "pork" (but recommending Americans reduce "cholesterol" and "solid fats" and failing to provide examples of foods containing these substances – meat, fish, egg and dairy). It urges Americans on reducing "saturated fatty acids by replacing them with monounsaturated and polyunsaturated fatty acids" (which, for the average American would be definitely clearer by saying "fewer animal foods, more plant foods"). What's trigged Simon's curiosity is that when it comes to advise Americans on foods they should eat, the *Dietary Guidelines* instantly abandons this language and provide concrete examples of foods (for instance, "vegetable, beans and peas"). This *modus operandi* costed USDA and HHS a lawsuit from Physicians' Committee for Responsible Medicine.

But even ignoring the fact USDA's recommendations deliver, to put it mildly, a mixed message by providing poor targets for healthy nutrition, even according to these targets adult males under fifty in the U.S. consume twice the recommended daily protein allowance and nearly twice the recommended maximum of saturated fat (Simon, 2013). Figure 1.3 shows the excess of saturated fat in other population groups, as of 2001-2002.

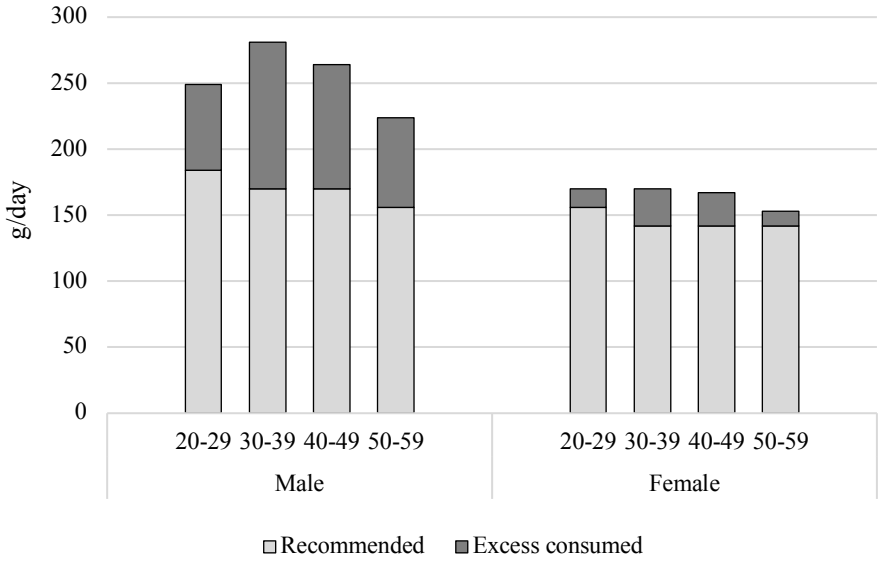
Because the United States does not publish child-related cholesterol guidelines, Simon (2013) used the EFSA guidelines and came up with a shocking 78% excess in saturated fat and 48% excess in cholesterol consumption (both linked primarily or exclusively to animal foods) in teenagers.

Figure 1.3 U.S. daily reference value and actual consumption of saturated fat



Source: USDA Economic Research Service (2011)

Figure 1.4 U.S. daily recommended and actual consumption of meat, eggs and seafood



Source: USDA Economic Research Service (2011)

At the same time, 1 in 3 American teenagers is obese or overweight (tripling the rate of 1963) and the number of those having diabetes or high blood pressure is growing: these are diseases directly linked to meat and dairy intake and "formerly seen only rarely before adulthood" (American Heart Association, 2014).

The same calculation has been done to compare U.S. daily recommended and actual consumption of meat, egg and seafood (see Figure 1.4).

But since dispensing nutritional advice is beyond the scope of this work, what is quite useful, instead, is to note how USDA recommends to eat less of the products it boosts the demand for through government mandated marketing (checkoff programs) and supports the supply of (through subsidies).

In short, Americans definitely don't need to buy more of these products. But why Americans are encouraged to do so by the USDA which has branches charged with protecting consumers by giving reliable nutritional advice? According to Simon et al. (2013) what's happening in America has an economic definition: it's called "regulatory capture". This is a form of government failure that occurs when an industry, which has greater financial stake in regulatory activity and, thus, is more likely to be interested in influencing the regulatory body than dispersed individual consumers, manages to push its own commercial or political concerns on political agenda. Because the prospects of getting re-elected depend on campaign contributions and because campaign contributions are given and influenced by special interest groups, a politician can be captured by such special interest. Accordingly, one of the USDA's main goals is "enhancing economic opportunities for agricultural producers" and "getting products from producers to… consumers". Other branches, like mentioned before, are meant to defend the public interest. When sales promotion and consumer protection go toe-to-toe it might become difficult to figure out what's the message, or even the mission, of the captured agency.

This institutional confusion impacts consumers directly by delivering bizarre results like USDA's brochure advising Americans to eat less cheese, while simultaneously overseeing and supporting advertisements that persuade American to buy more cheese. USDA even lacks of authority to use a mandatory recall of meat in case of contamination or any other possible suspects of damage for human health: all the main U.S. regulatory agency for animal food safety can do is to recommend that meat producers initiate a recall on their own, voluntarily (Simon, 2013).

In 2010 the Office of Inspector General issued a report finding that this lack of authority, coupled with insufficient processes to "detect and determinate safe levels of chemical residues in meat" costs Americans "quantities of meat entering the food supply containing pesticides, drugs, and heavy metals like arsenic" (Office of Inspector General, 2010).

Another federal agency in charge of promoting public health by supervising food safety and labelling is the Food and Drug Administration (FDA). USDA and FDA split their oversight duties in such complex ways that sometimes security measures are not enforced because of the

oversight gaps. For example, the FDA is responsible for seafood while USDA is responsible for meat and poultry. Nonetheless, FDA is also responsible for products containing 3% or less meat. With eggs, it's even more complicated: FDA is in charge for the safety of whole eggs, while USDA oversees both the safety of processed eggs and the packaging and labelling of whole eggs. When, in 2010, 380 million eggs were recalled from the market because of the salmonella outbreak, both agencies claimed to have fulfilled their regulatory mandates.

The United States does not require that genetically engineered (GE) foods bear any special labelling: it's on FDA. Even if it isn't fully known whether GE foods are harmful or not, public demand for such disclosure exists in the U.S. The lack of responsiveness on such issue might be explained, once again, by regulatory capture: for instance, when FDA claimed it was leaning toward approving the unlabelled GE salmon produced by AquaBounty, the company's stock raised by 600% (Simon, 2013).

A further issue dragging the agency into controversy: generally known as bovine growth hormone, rBST use was approved by FDA back in 1993 after the agency found "no significant difference" in a dosed cow's milk compared to that of an undosed cow (Simon, 2013). In 2010, a U.S. Court of Appeals disagreed on this matter, conclusively, stating that "a compositional difference does exist" and citing studies which links rBST to insulin-like growth factor 1 (IGF-1), a carcinogen, and other showing higher counts of somatic cells (which are pus cells arising from bacterial infection) in milk which has been treated with rBST. rBST is banned in Canada, Australia, New Zealand, Japan and in most of European countries because of its negative effects on human health, animal health and milk quality. FDA has not yet revised its view on the subject (American Cancer Society, 2014).

Another suggestive case concerns three antibiotics (penicillin, chlortetracycline and oxytetracycline) whose use to make farm animals grow faster is hugely controversial (Simon, 2013). In the mid-1950s FDA approved the use of these drugs at subtherapeutic levels (which is, at doses below those required to treat illness), but in 1972, an FDA task force found that even subtherapeutic use of these drugs led to antibiotic-resistant bacteria in both animals and humans. Federal law compels FDA to withdraw approval of animal drugs if they have been found unsafe by the agency: after 5 years of study, in 1977, subtherapeutic use of penicillin, chlortetracycline and oxytetracycline was "not shown to be safe". The statutory process to withdraw FDA approval was both started and cancelled in 1977: after the dismissal, FDA simply expressed its expectation that industry would voluntarily drop subtherapeutic animal drug use and released a set of nonbinding suggestions to industry. In 2012, a coalition of

consumers and scientists won a lawsuit against the agency, forcing it to resume the withdrawal process started in 1977 (Simon, 2013).

In light of these considerations the perception of American consumption of animal foods as demand driven might be questioned: consumers are responding to artificially low prices made possible (also) by subsidies and government propelled marketing operations by consuming more, so how much of this consumption is due to producers' behaviour (and government intervention), and is, therefore, supply driven? For instance, Rivera-Ferre's (Simon, 2013) researches show that "changes in production methods, such as the shift from traditional farming methods to low-cost industrial practices—and the resulting declines in retail prices—deserve most of the credit for the increase in consumption".

Moreover, labelling requirements are important because to communicate their willingness to pay a higher price for products respecting certain standards consumers have to be given this information when at grocery store: if producers are not compelled to disclose such information, consumers are prevented from making their choice being totally aware. Consumers may (and as we'll see, they actually do) prefer less cruel methods of raising livestock but, instead of favouring such measures, the U.S. legislation conceal animal abuse by making it illegal to expose it: the so-called ag-gag laws take care of that. And even if every U.S. state has some form of regulation prohibiting cruelty to animals, most of them admit exceptions to their anticruelty statutes: the so-called "Customary Farming Exemptions" (CFEs) (Wolfson & Sullivan, 2004). Essentially what CFEs do is pass the authority to decide whether a practice constitutes cruelty or not from lawmakers to the farmers themselves. Under CFEs, all it takes for a cruel practice, be it "to chop off all or part of an unanesthetized animal's body parts [or] to kill unwanted male chicks or laying hens by suffocation, starvation or disposal in a garbage can or wood chipper" (Simon, 2013), to become protected is for enough farmers to decide that it's expedient to implement.

In the last chapter the influence of the information about animal food production methods over consumers' willingness to pay and overall demand will be discussed. A sneak peak? According to some studies (Norwood & Lusk, 2011), after people are informed about actual animal conditions on factory farms and different production systems, over 70% are more concerned about the well-being of farm animals then they were before, this leading to a change in their purchasing patterns. So, all things considered, it is possible that supply-side forces may be impairing consumers' ability to make completely informed decisions when it comes to food.

1.2 Low prices and what's behind

Regulatory capture and its undesirable outcomes are common in many industries but what makes the animal food industry especially worthy of attention is the disproportionate negative economic impacts that this sector offloads on society.

Let's start with a closer look to the decrease in prices for animal products. Over the last five decades the average retail price for all meat has fallen nearly 69% (Norwood & Lusk, 2011): these price drops are attributable to the blossoming of agricultural innovation occurred in the period. One of them is the complete animal feed which is one the animal can obtain all its nutrient needs from. In the past animals had to be granted outdoor access in order to get all the nutrients their feed lacked: when a more sophisticated nutritional knowledge allowed for the development of complete feed, farmers could keep many more animals in confined spaces. For instance, the space allotment for pigs went from roughly 3 square meters in 1913 to about 70 square centimetres today (Norwood & Lusk, 2011).

These technological innovations had two important consequences. In the first place, they increased efficiency for each farmer. In 1900 it took 147 hours of work to produce 100 bushels of corn: today it takes only 3. In 1929, 85 hours were necessary to produce about 450 kilograms of broilers: today chicken producers do the same in only 1 hour (Gardner, 2002). It comes as little surprise that in the last half century people almost tripled their consumption of poultry: chicken price has fallen over 110% (USDA Agricultural Marketing Service, 2017). These efficiency gains involved all livestock sectors. For example, according to Capper, Cady, and Bauman (Norwood & Lusk, 2011) "dairy farms today only need 21% as many animals, 23% as much feed, 35% as much water, and 10% as much land as dairy farms did in 1944 to produce the same amount of milk".

Secondly, innovation created economies of scale. Becoming larger dropped the cost of production per unit and the efficiency gain implied that fewer farmers were expected to attain the same output. Technological innovation and economies of scale, by forcing food prices downward, drove the least efficient farmers out of the landscape: today, less that 1% of the American workforce is employed in agribusiness, compared to 30% in 1920.
Remaining farmers enlarged their operations and specialized in fewer commodities.

Figure 1.5 shows the increasing trend in animal food production. However, in the same period, the number of farms producing these commodities decreased considerably (see Figure 1.6). The glaring implication is that the average farm size has also grown during this period: in 1935 there were roughly 7 million farms, while today there are only about 2 million, with the average number of acres having more than tripled over the period (USDA Economic Research

Service, 2003). On the secondary axis the graph plots the number of commodities per farm, this being a measure of specialization.

Figure 1.5 U.S. farm output from 1948 to 2002

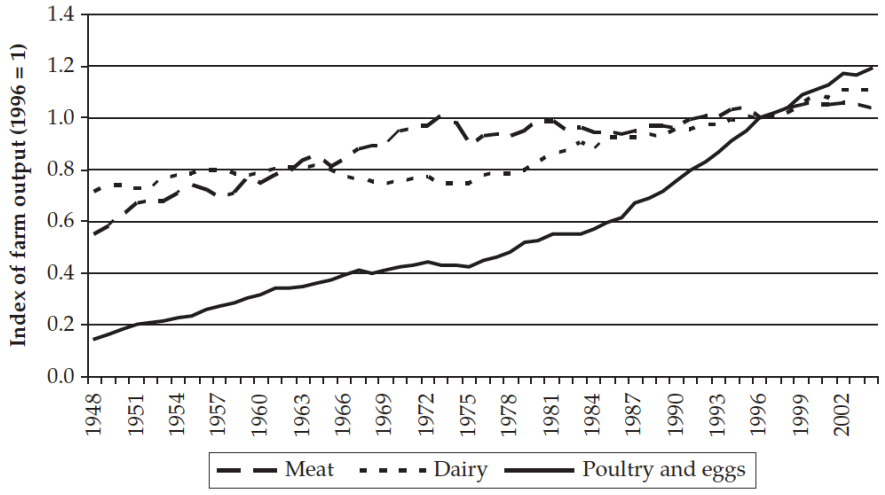
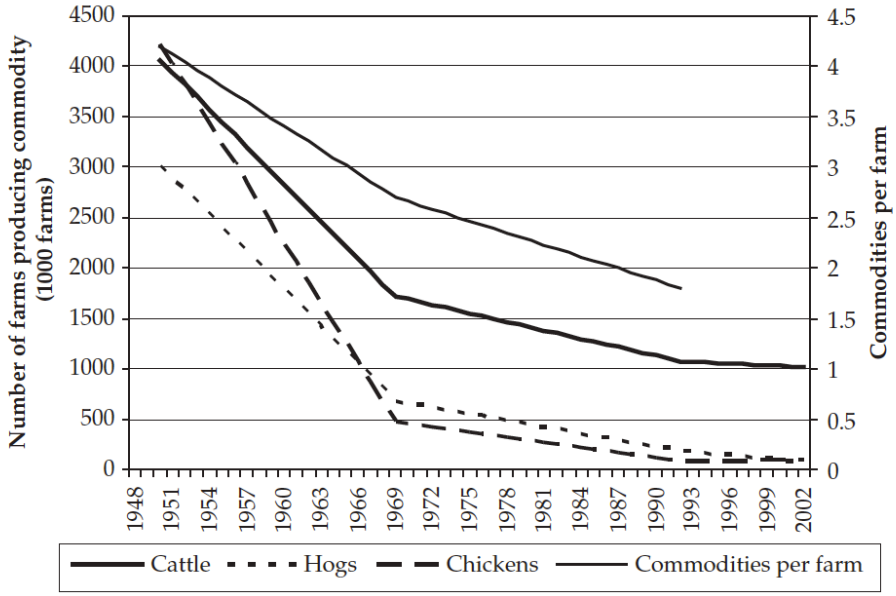


Figure 1.6 U.S. number of farms from 1948 to 2002



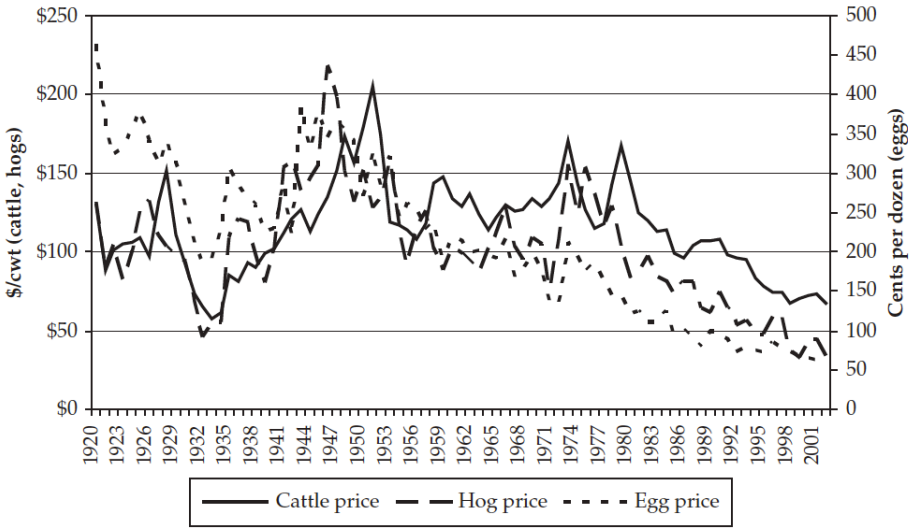
Source: Norwood & Lusk (2011)

The ultimate consequence of these transformations is cheaper food. The data in the Figure 1.7 refers to live cattle and hog and to fresh, conventional eggs, converted to 2002 inflation adjusted dollars using the standard consumer price index (CPI).

However, not all of the costs of animal goods production are reflected in the prices consumers pay at the cash register. Livestock rearing and aquaculture carry negative

externalities. Because an activity producing negative externalities offloads part of costs on others, he who carries such activity, since not facing the full amount of related costs, will produce up to a level which is not socially optimal.

Figure 1.7 Historical farm prices for live cattle, live hogs and eggs



Source: Norwood & Lusk (2011)

The need to internalise external costs in order to avoid market distortions and allow for efficient use of scarce resources is fully recognised (Compassion in World Farming, 2016). For instance, in a 2006 report Food and Agriculture Organization of the United Nations (FAO) argued that: "A top priority is to achieve prices and fees that reflect the full environmental costs [of livestock production], including all externalities… economic and environmental externalities should be built into prices by selective taxing and/or fees for resource use, inputs and wastes". Another report observes that "in many countries there is a worrying disconnect between the retail price of food and the true cost of its production. As a consequence, food produced at great environmental cost in the form of greenhouse gas emissions, water pollution, air pollution, and habitat destruction, can appear to be cheaper than more sustainably produced alternatives" (FAO, 2015).

The problem with externalities is that, since they represent non-market-reflected values, it's not always easy to monetize them (let alone find politically feasible ways to internalise them). In the following taxonomy the main externalities deriving from animal foods production and consumption will be shortly mentioned. The next two chapters will deepen the analysis by picking some physical and psychological externalities, monetizing them and overviewing possible ways to internalise them in final prices.

1.3 A taxonomy of negative externalities

Livestock is a major player when it comes to global environmental issues (FAO, 2006). The pressure it puts on natural resources alone is high and pervasive, involving air pollution, water depletion and pollution, biodiversity loss and land degradation.

Overall, livestock activities contribute an estimated 18% to total greenhouse gas (GHG) emissions, carbon dioxide, methane and nitrous oxide being the major pollutants. To get some perspective, this is more than the combined exhaust from all the transportation put together (equalling 13% of the total, from road, rail, air, and marine transportation) (FAO, 2006). This might even be a conservative estimate because, as new studies emerge (Goodland & Anhang, 2009), the total contribution is argued to be 51%: the results will be further illustrated in the next chapter.

These emissions are projected to increase 80% by 2050 (Tilman & Clark, 2014): agricultural GHG emissions alone will be able to push global temperatures to increase by almost 2°C by 2050, although the international community, by the Paris Agreement, has set the limit to the global temperature increase to well below 2°C (for all GHG emissions regardless of the source).

In terms of water consumption, in the U.S. growing feed crops for livestock consumes 56% of fresh water (Jacobson & Center for Science in the Public Interest, 2006): for the sake of comparison domestic use accounts for 5%. The amount of water used to produce 1 kg of beef is about 21.029 litres, this being a conservative number from Borgstrom (1981); the actual amount varies greatly from 3718 to 67 295 litres per kilogram (Beckett & Oltjen, 1993). Roughly 1000 litres of water are needed to produce 1 litre of milk (Hoekstra, 2008). 4013 and 7571 litres of water are required to produce 1 kilogram of eggs and cheese, respectively (Environmental Working Group, 2011).

Besides depletion issues, animal agriculture is responsible also for freshwater resources pollution: in the United States sediments and nutrients are estimated to be the main water-polluting agents, contributing with pesticides for a 37% of U.S. total and with antibiotics for a 50%. Then, of course, there is the problem of manure produced by livestock. Animals were once attached to land, where they grazed and returned waste to the soil as fertilizer: when it was found that decoupling livestock from real estate allows greater productivity and scalability, manure and other waste management started to require quantities to process so big that natural recycling capacity simply wasn't capable to deal with (Simon, 2013).

Livestock covers 45% of the total earth's land (Thornton et al., 2011), being the main cause of desertification for nearly 1/3 (United Nations, 2012). Animal agriculture is also

responsible for up to 91% of the amazon destruction (Margulis & World Bank Group, 2003) which, in turn, leads to as much as 137 plant, animal and insects species loss every day (Rainforest Action Network). Biodiversity loss is critical also due to wild animals killings to protect livestock (Predator Defense, 2016) and to by-catch and by-kill while fishing: according to FAO, for every kilogram of fish caught, up to 5 kilograms of unintended marine species are caught and discarded as by-kill, with as many as 40% (which is close to 29 billion kilograms) of fish caught globally every year, discarded (Keledjian et al., 2014).

But when it comes to negative externalities, animal agriculture doesn't spare anyone: to the aforementioned negative effects (which, by affecting environment affects humanity in ways which can be more or less tangible), health care costs due to animal food consumption and what we're going to call psycological externalities must be added. Since these externalities are more difficult to define, analyse and to be assigned a monetary value, they will be dealt with in a separate chapter.

Chapter 2

Environmental issues and related costs as externalities

As already mentioned, livestock industry has a major impact on natural resources of all kinds. In this chapter a deeper analysis of some production processes which lead to major environmental damage will be conducted. The next step will be to present estimation methods commonly used by environmental economists to monetize such damage, since costs expressed in monetary values, although not always easy to come up with when dealing with economic environmental externalities, are required to attempt some reasoning on how to internalize externalities into retail prices of the covered commodities. In this chapter will also illustrate policy options and economic measures for addressing environmental externalities, which ideally would lead to a new, socially optimal, level of production, therefore increasing total welfare. The last paragraph is dedicated to a brief summary of the remaining externalized costs of animal sector.

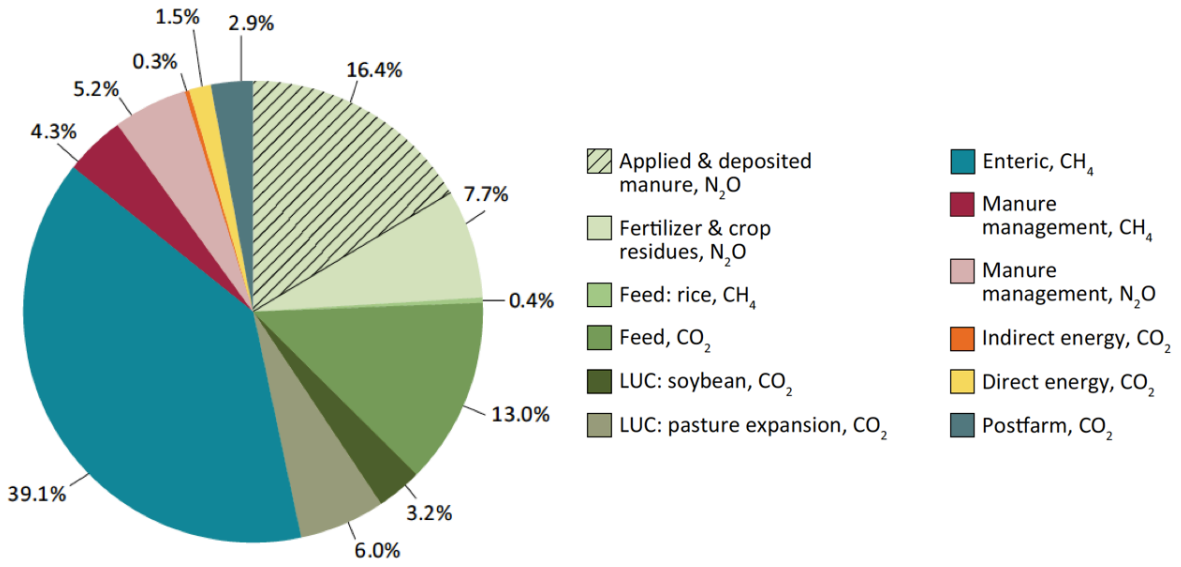
2.1 GHG-related emissions description and assessment

Greenhouse (GHG) emissions caused by livestock rearing account for a total 18% of all human-induced emissions, equalling 7.5 gigatonnes CO_2-eq per annum for the 2005 reference period (FAO, 2006). This estimate is to be considered conservative, as in a more recent study Goodland and Anhang (2009), who went beyond the previous assessments to evaluate overlooked, undercounted and misallocated emissions, came up with a total 51% of all man-made sourced GHG emissions attributed to livestock (32.6 gigatonnes). Because, in my own experience, during most conversations people are astonished, and sometimes even sceptical, about the evidence that animal agribusiness' share is bigger than that of the combined exhaust from all the transportation put together (13% according to FAO), something we use to associate with the idea of air pollution, a brief description of damage mechanisms and sources is worth being pursued.

For this purpose, the Global Livestock Environmental Assessment Model (GLEAM) will be referred to. This model was recently developed at FAO to improve the understanding of livestock GHG emissions and to test the effectiveness of mitigation practices, which are "anthropogenic intervention[s] to reduce the anthropogenic forcing of the climate system" (United Nations Environment Programme, 2016). The model represents the main activities of global livestock supply chains and analyses the environmental implications of production practices used in five modules, dealing with different phases of supply chain: herd, feed, manure, system and allocation (FAO, 2013).

As illustrated in Figure 2.1, the aggregated picture has four main emission pathways: enteric fermentation, manure management, feed production and energy consumption. Because there are three main GHGs (methane, nitrous oxide and carbon dioxide), for every source of emission the most involved ones are indicated (FAO, 2013).

Figure 2.1 Global emissions from livestock supply chains by category of emissions



Source: FAO (2013)

- Emissions from enteric fermentation in the form of CH_4 (methane) are caused from ruminants' digestive process;
- Methane and N_2O (nitrous oxide) come from manure management, releasing GHG emissions during manure storage and processing;
- CO_2 (carbon dioxide) and N_2O emissions from feed production, processing and transport, carbon dioxide being connected to the expansion of feed crops and pasture into natural habitats (which leads to the oxidation of C in soil and vegetation) and to soil sequestration (the so-called land-use change from the transformation of forest to pasture, causing deforestation); carbon dioxide is also originated from the use of fossil fuel to produce fertilizer, and process and transport feed. Nitrous oxide emissions, instead, are due to the use of fertilizers for feed production and to the deposition of manure on pasture or its management;
- CO_2 from energy consumption that occurs along the entire livestock supply chains because of fertilizers production, use of machinery during various production phases and transportation of final animal commodities.

2.2 Evaluation methodology

From an economic point of view, "economic pollution" is a result of both the physical effect on the environment and the human reaction to that physical damage. In physical terms pollution refers to the introduction of harmful substances into a natural environment, resulting to a damage inflicted upon living organisms. Air pollution affects humans as well, causing allergies, diseases and, in most extreme situations, even death. Human reaction to such phenomenon is expressed through concern, distress and anxiety and it's representative of a certain loss of welfare.

Livestock-originated air contamination is a typical case of anthropogenic pollution, meaning it is induced by some sort of human activity (and not from natural source), but once we recognize that the concept of "economic pollution" exists, we also imply that its impact is measurable in terms of costs and benefits. It's not that straightforward to think about pollution in terms of benefits but they actually arise when we obtain utility by producing or consuming goods which constitute the output of activities generating pollution in the first place. The costs of pollution are due to the fact that environmental quality changes, making it impossible or more expensive to enjoy the natural resources (something humans, or at least some of them, derive utility from). Negative externalities are parts of costs which producers and consumers enjoying goods provided by polluting activities are not charged for. This, of course, doesn't eliminate the costs themselves, but, as we've already seen, creates a higher level of social costs non incorporated into private marginal costs of producers (and, therefore, neither into retail prices), leading to an unneccessarily and harmfully high production level and misallocating scarce resources.

If the natural capacity to provide consumers goods and services, even by their mere existence and not through direct and consumptive use (the so-called "non-use values"), is impaired by pollutants, consumers are forced to foregone the relative benefits. If such benefits can be assigned a value (environmental value) and are prohibited because of environmental alterations, they must be accounted for as utility loss: from this point of view they can be thought of as part of the costs resulting from disruption in conditions which determine the flow of goods and services natural resources provide.

Environmental economics usually relies on three major approaches to estimate environmental values: market prices, surrogate market valuation and expressed preference approach (or contingent valuation method). As the first method exploits the existence of market prices for environmental goods it would fail to provide reliable values if some of the goods or services are unmarketable. The surrogate market valuation partly overcomes the problem by

assigning unmarketable environmental goods and services related goods' market prices, but once again, if the value of the natural resource is not revealed by a complementary or a substitute good's behaviour, it proves unable to fully reflect such value. Finally, the expressed preference approach operates by directly involving individuals: consumers are asked to attach a value to unmarketables and to express their preference towards changes in service flows.
Market prices method requires goods and services to be purely private in order to deliver a full estimate, and expressed preference methods come in handy when dealing with environmental goods and services holding pure public features. For public or quasi-public non-marketed environmental goods and services economists turns to both surrogate market valuation and contingent valuation method, preferring the latter when no relevant private goods are involved.

In case of air pollution, contingent valuation method might not deliver reliable values because the average respondent is unlikely to be informed enough about environmental damages and effects on his/her own health to measure a plausible environmental value: this approach, instead, will be used to measure the so-called psychological externalities in Chapter 3. In case of physical externalities related to environmental damage cost-based methods (related to surrogate market valuation approach) might provide more solid values.

Since air pollution has direct repercussions on human health, it's logical to infer that even people who are not entirely informed about the extent of allergies and diseases they might incur are willing to avoid or reduce health risks: the averting behaviour approach values the increase or decrease in environmental quality by looking at the level of averting expenditure. This method can be used only if the costs bore to mitigate or prevent polluting effects can be computed. When relocating is the only option to avoid harmful effects, the value of environmental quality can be inferred by considering the willingness to pay (WTP) additional costs to move to a less polluted area.

When, for some reasons, individuals are unable to respond to environmental threats by undertaking defensive actions, the loss of welfare due to air pollution can be inferred by considering increases in morbidity levels or mortality rates and monetizing the associated economic costs.

Another method which can be possibly used, even if it relies more on respondents' awareness about environmental damages (which, as already argued, may prove insufficient to provide a realistic cost estimate), is the hedonic pricing method. This valuation relies on the assumption that the utility an individual derives from the consumption of a given good or service is based on its attributes. As long as the changes in environmental quality comprehend goods and services possessing such attributes, by inferring individuals' WTP, hedonic pricing

method tries to assess the impacts of environmental changes on individuals' utility levels. In case of air polluting, hedonic pricing may be used to measure an individual's WTP for a property located in an area with higher/lower levels of contaminants.

Even if it remains extremely hard to nail down precise estimates when it comes to environmental costs and there are no definitive results yet, the following estimates are some of the best attempts to take on this challenge.

2.3 Air pollution related costs

The Intergovernmental Panel on Climate Change (IPCC), a UN-formed expertise body aiming to assess the science related to climate change, calculated that the U.S. could mitigate climate change by spending less than 0.12 of American gross domestic product, every year (IPCC, 2007). Simon (2013) suggested that by multiplying the total GDP mitigation related expenditure for the percentage of climate change contribution livestock sector is responsible for, we can come up with some estimate of how much animal industry costs us in terms of environmental damage.

[U.S. 2015 GDP (The World Bank, 2017)*: $18.037 trillion]* $\times$
[IPCC estimated expenditure for mitigation: 0.12%] $\times$
[livestock contribution to total GHG anthropogenic emissions: 18%] $=$ *$3.9 billion*

By not sticking to the conservative percentage related to animal industry contribution and considering the study by Goodland and Anhang (2009) instead, the total mitigation expenditure would rise to $11 billion.

Another way to look at the problem would be to consider the health-related costs caused by the harmful effect of air pollution. A study by Caiazzo et al. (2013) analyzed the number of premature deaths occurred across the U.S. because of air pollution effects and came up with a total 200,000 early deaths per year. Because to attribute economic value for each life in the so-called human-capital approach would be problematic within the framework of this work, we can use this estimate to calculate the economic burden due to the loss in labor income and decreased productivity, as suggested by a study by the World Bank Institute for Health Metrics and Evaluation (2016). The study is age normalized and corrected for such factors as years of work still remaining among different age groups (e.g., because children have more years remaining in their lifetime in which they are likely to work, the expected loss of income per child's death is usually greater than that of an elderly).

Since the study estimated that for the U.S. the foregone labor output provokes a loss on the order of 0.15% of GDP equivalent in 2013, yearly, for air pollution not related to household sources (which we exclude for the scope of this work):

[U.S. 2013 GDP (The World Bank, 2017)*: $16.7 trillion] ×*
[loss due to foregone labor output/GDP: 0.15%] = $25 billion in labor income loss

Multiplying the total labor income loss for the livestock sector contribution to air pollution:

$25 billion × 18% = $4.5 billion by choosing the conservative number or,
$25 billion × 51% = $12.7 billion by choosing the estimates by Goodland and Anhang (2009)

However, according to the study, the total welfare losses caused by air pollution accounted for 3% of GDP equivalent in 2013, so, to include the total effect:

[U.S. 2013 GDP (The World Bank, 2017)*: $16.7 trillion] ×*
[loss due to foregone labor output/GDP: 3%] = $501 billion in total welfare loss

Multiplying the total welfare loss for the livestock sector contribution to air pollution:

$501 billion × 18% = $90.1 billion by choosing the conservative number or,
$25 billion × 51% = $255.5 billion by choosing the estimates by Goodland and Anhang (2009)

2.4 Policy options and challenges

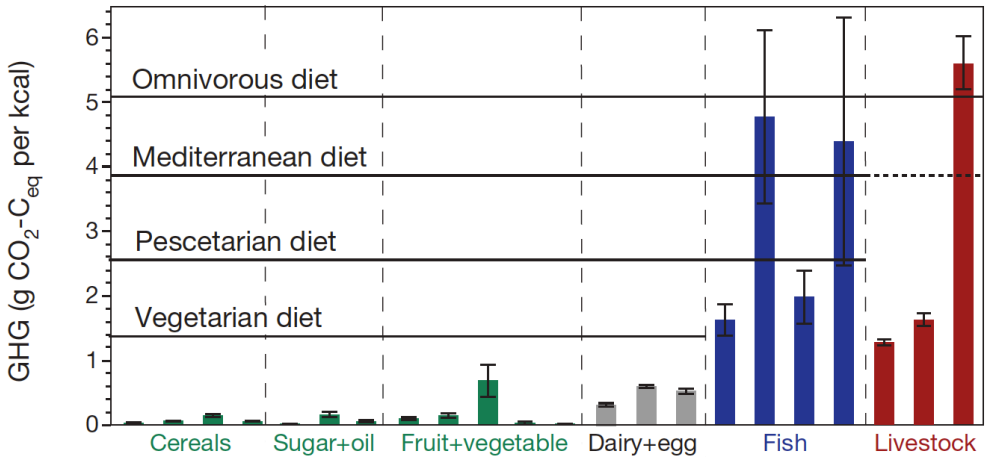
Because the air pollution related externalities caused by animal sector are caused by emissions, to reduce such externalities means to reduce emissions in the first place. Reducing emissions may be achieved by lowering production and consumption levels (which is internalizing costs into retail prices, in a sort of indirect intervention on the emission source), by decreasing the emission insensity of production (which is intervening directly on the emission source), or by a combination of the two (Gerber et al., 2013). Because of the nature of this work, this paragraph will mainly investigate the potential of measures aimed to reduce production and consumption levels for livestock products.

First things first, several authors have already assessed the mitigation potential of different dietary change scenarios, proving not only the substantial mitigation effect of reducing animal

based food consumption, but also its relative cheapness when compared with alternative mitigation strategies (Stehfest et al., 2009). Furthermore, positive effects on human health are also reported after reducing animal protein intake (McMichael et al., 2007; Stehfest et al., 2009).

For instance, Figure 2.2 shows GHG footprint of 4 different dietary paths.

Figure 2.2 GHG footprint based on food/diet type



Source: Tilman & Clark (2014)

When efficiency is promoted, an intervention to regulate production and consumption levels often proves necessary. Because lower emissions per output unit are usually associated with improved efficiency, common policy approaches are focused on fostering knowledge transfer, enabling conditions for technology transfer and innovations and creating incentives for efficiency improvement. Such incentives may comprise financial instruments where upfront investments are required in order to adopt more efficient technologies, and their adoption is prohibited by ineffective or missing capital markets and financial services (Gerber et al., 2013). But because efficiency improvements cause production to expand, thus inducing higher emissions, also constraining policies are needed in order to support mitigation. The issue is common both on the agricultural and industry scale (Alcock & Hegarty, 2011; Perman et al., 2003): in the latter, in particular, mitigation practices that increase profits can attracts new entrants, increasing the total output and, therefore, also emissions (Perman et al., 2003).

As already discussed, when dealing with externalities we observe discrepancies between private and social costs: misallocation effects such as overproduction of environmentally harmful products (because pollution is produced at zero price) and the consequential overuse of natural resources then follow. To align the pollution level to a socially efficient one (meaning

the production level at which the extra benefit from changing the quantity by one unit is equal to the extra damage done by pollution arising from activity) a government intervention is necessary because of the public value included in environmental goods and services. However, to set the ideal production level may prove difficult because policy makers are not omniscient, yet they have to compromise between different demands and expectations (different groups having different concepts of what is the "right" pollution level according to their ideas and interests involved): so usually, because the socially efficient targets are not politically and technically feasible, in the real world environmental policies typically deal with politically "acceptable" or "realistic" targets. Within this framework, an efficient environmental policy is the one allowing to reach the arbitrarily defined target at minimum cost.

To implement their environmental policies, governments could use both the so-called command and control measures, by promulgating regulations to prescribe standards polluters must comply with and enforcing them, or by means of market-based instruments, seeking to achieve pollution abatement by economic incentives. The poorer the information about abatement costs regulators have access to, the more ineffective the command and control measures. Market-based instruments define a total emissions limit and distribute or sell a number of tradable emissions allowances (permits) which can be sold by polluters if they are able to keep emission levels below their allottment. In this system compliance is measured by comparing actual emissions with the permits sold. However, it poses the problem of how such permits should be initially allocated and holds to some assumptions regarding the market competitiveness which may not be respected in the real-world markets.

To disincentivate the demand side forces measures modelled on the "Pigouvian tax" may be operated by incorporating the marginal external costs into final prices, therefore reducing the gap between private and social costs. More consideration about the effects of such measures on consumers' behaviour will be discussed in the last paragraph of Chapter 3.

2.5 Other costs

We've seen the reasoning behind some attempts to estimate economic costs related to environmental externalities in animal agribusiness and industry. These costs vary greatly because they relies on assumptions which depend on other estimates and estimates are not always definitive and univocal.

Table 2.1 Summary of the annual externalized costs of U.S. animal food production

	Reference year	Nominal cost ($ billions)	2017 inflation-adjusted ($ billions)
Environmental costs			
Soil erosion	1992	9.4	16.3
Pesticide use on feed crops	2003	5.0	6.6
Eutrophication of waterways	n/a	2.2	-
Real property devaluation	1999	1.8	2.6
Manure spreading vs. storage	2005	1.2	1.5
Manure lagoon repair	2003	0.8	1.1
			30.3
Fish production			
By-catch	2010	2.3	2.6
Overfishing	2010	1.4	1.6
Fish farming	2009	0.6	0.7
			4.9
Health care			
Heart disease	2008	133.3	150.3
Foodborne disease	n/a	83.7	-
Cancer	2007	75.6	88.5
Diabetes	2007	55.1	64.5
Antibiotic resistance	2000	17.5	24.7
Salmonella poisoning	2010	1.3	1.4
E. coli poisoning	2010	0.3	0.3
			413.4
Total			448.6

Source: Simon (2013), Compassion in World Farming (2016), Dodds et al. (2009), Hoffmann et al. (2015); Scharff (2010)
Notes: Data about eutrophication of waterways and foodborne disease is extracted from estimates contained in Dodds et al. (2009); data about foodborne disease results from the midpoint between two different studies which calculated costs equal to $15.5 billion (Hoffmann et al., 2015) and $152 billion (Scharff, 2010)

Although these costs are huge, they are only relative to one kind of environmental externality imposed by animal sector on American society. Without going into too much detail, it's worth mentioning the others, as collected by Simon (2013) from multiple studies and researches (see Table 2.1).

It's worth noting that including health care costs among externalities is not that straightforward since, first of all, the underlying health care system must be analysed: in case

of fully private system, health care costs are not to be considered among externalities because individuals sustain such costs for themselves by paying higher premiums for their own health insurance. Because the U.S. has a two-tier health system, where basic care is provided by government, and a secondary tier of care exists for those who can or are willing to afford additional, better quality or faster access, a more detailed investigation on the studies underlying Simon's calculations might prove useful.

Secondly, this data doesn't include monetary costs for extinction of species linked to agribusiness activity because of the difficulties in determining causality when agriculture disturbs complex ecosystems (Simon, 2013). Some of these species' services provide direct economic benefits: for example, honeybee pollination have an estimated value of $215 billion worldwide and U.S. honeybee colonies were more than halved in the last 50 years (van Engelsdorp et al., 2008). Some theories associate bees' disappearance with direct and indirect effects of agribusiness (Simon, 2013), so considering the foregone associated benefits is another excluded estimate which might be worth looking into.

Chapter 3

Animal welfare issues and cruelty related costs as externalities

One of the first and most important lessons we get from economics is that resources are scarce. Scarcity implies imbalance between resources on the one hand and our desires on the other, making trade-offs an everyday necessity: employing any scarce resource, would it be money, time, land or coal, to achieve one end means it cannot be used to achieve another end anymore. People manage their own resources' scarcity by choosing their allocation and, in particular, by expressing certain willingness to pay when it comes to managing money. This mechanism can prove useful in order to analyse the so called psychological externalities caused by livestock sector.

3.1 Attempting to measure animal willingness to pay for improved welfare

When we are talking about animal welfare and cruelty from an economic point of view, we have to talk in terms of human welfare since, according to the widely adopted anthropocentric point of view, animals' utility matters as long as it, directly or indirectly, affects human well-being: since there are people who care about factory farm animals' conditions and, further, suffer (that is, experience utility loss) by knowing that they are treated cruelly or slaughtered, if liable to be estimated in metrics economists can work with, these factors might represent negative externalities of livestock sector. Moreover, since the aforementioned people are consumers, expressing their preferences by means of their willingness to pay, such externalities can be calculated in monetary terms by considering, for example, the extra value they are willing to pay at cash register for cage-free eggs or tuna fished without harming other species through by-catch and/or by-kill.

Unfortunately, this approach can be limited in real markets. In the first place, the people who cares the most about animal well-being actually aren't expressing any higher willingness to pay for the improved conditions of factory farm animals simply because they aren't expressing any willingness to pay for animal goods at all: by not consuming animal derived goods they communicate by not expanding the demand for those goods, but such signals can't be monetized looking at market prices.

Secondly, it's not always easy to find such thing as crate-free pork or free-range poultry, so some consumers' choices are not truly revealed in the market place. Sometimes, as already mentioned, labelling requirements are so low that people can't choose between production processes simply because they are prevented from distinguishing one from another.

Third, many consumers are not fully informed about how factory farm animals are raised and it's safe to assume that they might make a different set of choices if more aware. For instance, a research conducted by Norwood and Lusk (2011) shows that, although 95% of all egg laying hens in the U.S. are raised in cage systems, most people think only 40% are raised this way (believing that the remainder live in cage free facilities). In a survey which will be later discussed, they interviewed 300 people face to face and 1000 over the phone, noticing that the ones interviewed face to face strongly opposed the same methods half people interviewed over the phone seemed to accept. The inter-group differences lie in the fact that the people met in person were provided with detailed information about how farm animals are raised, including information on factors affecting farm animal welfare and a discussion on possible alternative production systems. The findings showed that the more consumers were informed about production methods for instance for egg, pork and veal, the more inhumane they deemed the industries to be.

These reasons led Norwood and Lusk to turn to research approaches that rely on direct or indirect asking people their values for improved animal welfare within the framework of a specially designed market, in a sort of economic laboratory. This approach also allows consumers to be given information about production methods in order to make a fully aware decision.

Measuring consumers' WTP is not as far as we could go: a nascent concept of animal WTP is arising, with researchers continually contributing to the topic and scientist having developed quantitative models to describe how animal well-being varies when an animal's environment is altered. The assumption that animals, just like people, could potentially express their willingness to pay, starts to have more importance thanks to works of researchers who showed that animals have preferences and make rational trade-offs when exposed to changing incentives, using methods similar to those commonly adopted to understand human preferences (Kagel et al., 1995): for instance, one study by Matthews and Ladewig (1994) explored how hard pigs were willing to work (by pressing a lever on a nose plate) to have food versus social contact with another pig. This specific study varied the number of presses (effort) necessary to obtain a commodity (food or socialization), with effort being a proxy for price. The findings showed that as the required number of level presses to get food increased by 1%, animals reduced their willingness to work by 0.02%, compared to a decrease of 0.49% for social contact. In this case, the marginal rate of substitution is the most amount of food the pig would renounce to get one extra unit of social contact without becoming worse off overall: to make it something similar to a person's WTP and express the value in terms of dollars, the animal's WTP is

multiplied by the price of corn which is the most widely used animal feed. Since the marginal rate of substitution is $\frac{\Delta y}{\Delta x}$, and Matthews and Ladewig were basically asking the pig how much food it was willing to give up to get one additional unit of social contact, under a set of assumptions about the hog's utility function (Norwood & Lusk, 2011) and the current corn price being \$0.074/lb (USDA Agricultural Marketing Service, 2017) (since the study used pound as units; 1 pound ≈ 0.45kg): 0.49/0.02 = 24.5 units of feed. The resulting animal's WTP is \$1.81 (24.5 × 0.074). Studies like this illustrates that animal WTP can be calculated and this pose some issues about how the cost benefit analysis should be performed in order to take it into account.

When discussing animal welfare, Norwood and Lusk (2011) argued that by considering only human related benefits and costs (leaving out of the picture benefits and costs affecting animals, which, as we'll see, are the third party suffering the most from externalities) a cost-benefit analysis would be speciesist. To avoid such accusation the welfare of animals should enter CBA not just through its effects only on human well-being. The problem is that some of the benefits people who care about animal welfare receive are inextricably linked to the benefits the animal themselves are expected to receive. If we suppose that a pig is willing to pay the animal equivalent of \$100 to move to an open barn and that, knowing that the hog would be happier by moving, a human consumer might be willing to pay \$10 for the policy, we can imply that if the hog's WTP increases to \$1000, human WTP would increase too. According to some economists this is like double counting benefits because we add animal's benefit once and then we add them again when considering human benefits, where they are already included. The solution might be to conduct a CBA logically ignoring human altruism, but it's quite unlikely that real policies will respond to any species which don't have political power, ignoring part of the benefits which belong to the only one voting.

However, we saw that animal WTP can be measured, and the fact that researchers start to be interested in doing so means the issue is gathering attention. We might as well assume that leaving it out of the picture would stop being an option in the future. Animal WTP is a nascent concept and how its estimates should be compared or combined with human WTP in cost-benefit analysis remains the bigger question (Norwood & Lusk, 2011).

For the scope of this work consumers' willingness to pay will be framed out of the CBA approach and used as a measure of negative externalities caused by current production processes: the assumption behind this approach is that if consumers are willing to pay a certain price to, for instance, stop cruel practices on factory farms, they assign a value in such a way that it reflects the emotional discomfort it brings them knowing how animals are actually raised

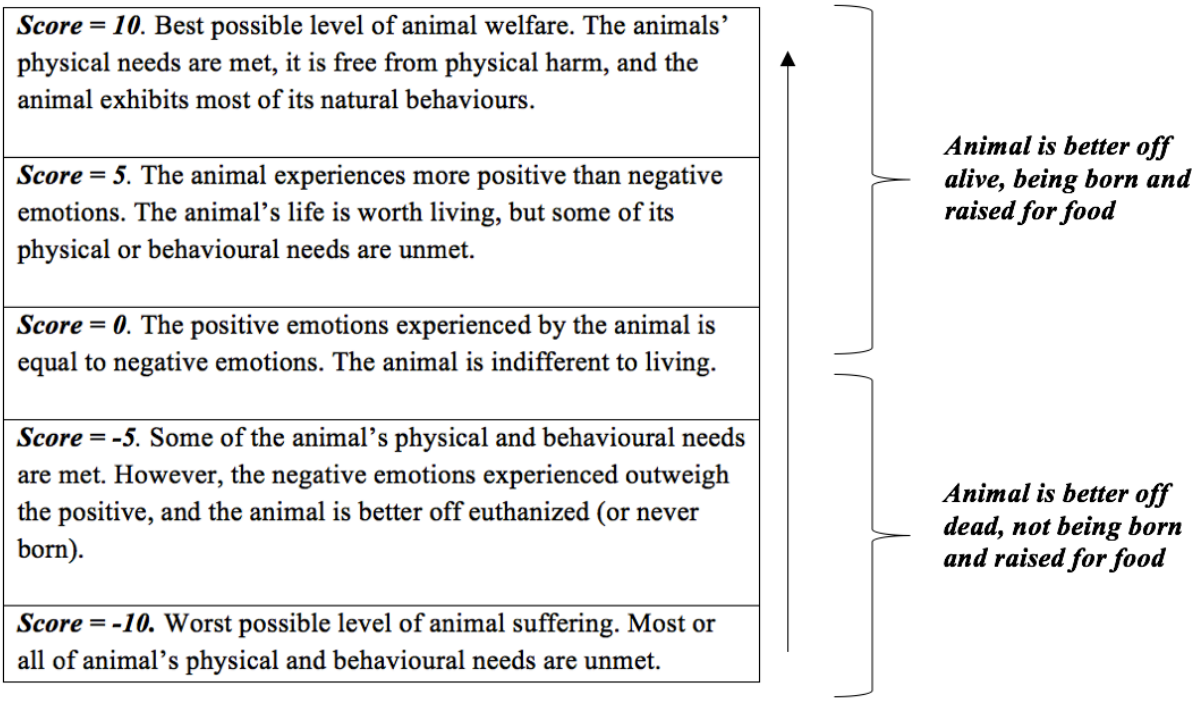
and slaughtered. Since this distress is valued by those who suffer from it in monetary terms it's the best approximation we can get of psychological externalities imposed on society by animal industry and its current practices.

3.2 Calculating the consequences of consumers' preferences

Before surveying people about their preferences, Norwood and Lusk (2011) developed a tool in order to guide consumers while forming their preferences and to allow them to predict the outcome of their individual and collective choices: the so-called Ethical Eating Assessment Tool (EEAT).

This tool measures the variation in animal welfare due to different patterns in consumption of animal food and it relies on three variables to do so: animal well-being scores, animal numbers and supply and demand dynamics.

Figure 3.1 Welfare scores used within EEAT framework



Source: Norwood & Lusk (2011)

Animal well-being score is measured on a scale between -10 and 10 and is related to consumers' perception of the animal well-being under certain conditions. This score is useful to decide whether we believe the animal is better off alive and raised for food, or it would've been better off if it had never existed, and therefore to consistently align consumers' choices about animal

products with their beliefs and values. More detailed information about the measurement scale is provided by Figure 3.1.

The second part of the equation EEAT relies on is the number of animals affected by our food choices. Since we assume that misery and merriment are emotions that occur within the animal brain, we want to calculate the relationship between pounds of meat and numbers of brains to determine the effect of increasing or decreasing our consumption of meat (in terms of pounds). Table 3.1 illustrates the number of livestock harvested (under federal inspection) in the U.S. in 2008 (NASS, 2008, 2009a, 2009b).

Table 3.1 Number of livestock harvested in the U.S. in 2008

Livestock type	Number harvested in 2008
Beef cattle (mother cows and bulls)	4,173,900
Beef cattle (not bred)	27,040,000
Veal calves	942,000
Hogs (sows)	3,960,000
Hogs (not bred)	111,460,700
Dairy cows	2,591,200
Broilers (1997)	9,031,035,000
Turkeys (1997)	264,969,000
Laying hens	340,000,000

Source: NASS (2008, 2009a, 2009b)

The number of animals affected by one-pound variation in consumption follows from calculations by Norwood and Lusk (2011). For example, how many laying hens are involved in your choice to consume 1 egg? During its lifespan in a cage system a laying hen will produce 509 eggs. By consuming 1 egg you are responsible for 1/509 of its total output. But since also the number of breeder animals per livestock unit is to be considered, and for every laying hen this number is about 0.01399, that 1 egg is relevant not only to 1/509 laying hens but to (1/509) × (0.01399). Final calculations for different farm animals are shown in Table 3.2. These numbers present some caveats as they don't reflect the different lifespan of animals, which may impact the degree of misery or merriment they experience.

Table 3.2 Number of animals associated with production of select food items

Food item (in lb unless otherwise noted)	Number of breeder animals associated with		Number of non breeder animals associated with	
Beef	0.000600601	cows	0.001201201	cattle
Chicken	0.001804675	chickens	0.259740260	broilers
Milk			0.000017429	cows
Veal			0.006849315	calves
Pork	0.000167336	sows	0.007195450	hogs
Crate free pork	0.000167336	sows	0.007195450	hogs
Shelter pasture pork	0.000175193	sows	0.007182901	hogs
Cage egg	0.000027491	chickens	0.003184713	laying hens
Cage free egg	0.000044554	chickens	0.003184713	laying hens

Source: Norwood & Lusk (2011)

The final aspect of EEAT is the supply and demand dynamics. A consumer who increases or decreases his/her consumption of animal goods impacts demand and supply of these goods according to their respective elasticities. Following Norwood and Lusk (2011), let X be the per capita consumption of a food and N the population, making NX the total consumption of the good. The variation in an individual's consumption is noted with δ. If we assume that the price didn't change after a demand shock, the percentage change in quantity demanded would be:

$$\%\Delta \mathrm{Q_D} = -\delta / NX$$

However, from the basic model of demand and supply we know that the price will change: as a consequence of demand increase the price will fall, increasing someone else's consumption and inducing suppliers to produce less. To predict the exact amount of these changes we need to know how sensitive are firms and consumers to variations in prices, demand and supply elasticities being the proxy of such sensitivity. If we use $\mathrm{E_D}$ and $\mathrm{E_S}$ to indicate demand and supply elasticities, respectively, and $\%\Delta \mathrm{P}$ be the new equilibrium price after the consumption decrease by $-\delta$, the changes in quantity supplied ($\mathrm{Q_S}$) and demanded ($\mathrm{Q_D}$) are:

$$\%\Delta \mathrm{Q_S} = \mathrm{E_S}\,(\%\Delta \mathrm{P})$$
$$\%\Delta \mathrm{Q_D} = \mathrm{E_D}\,(\%\Delta \mathrm{P}) - \delta / NX$$

By equalling the two equations and solving for the change in price, we get:

$$\%\Delta Q_S = \%\Delta Q_D$$
$$E_S\,(\%\Delta P) = E_D\,(\%\Delta P) - \delta/NX$$
$$\%\Delta P = {(-\delta/NX)}\Big/{(E_S - E_D)}$$

Finally, by plugging $\%\Delta P$ back into the supply and demand equations, we solve for how one's person's decrease in consumption by $-\delta$ impacts total production and consumption of the good:

$$\%\Delta Q_S = E_S\left[{(-\delta/NX)}\Big/{(E_S - E_D)}\right]$$
$$\%\Delta Q_D = E_D\left[{(-\delta/NX)}\Big/{(E_S - E_D)}\right] - \delta/NX$$

The total decline in consumption of the given good is:

$$\Delta Q_S = E_S\left[{(-\delta/NX)}\Big/{(E_S - E_D)}\right](NX) = -\delta\left[{E_S}\Big/{(E_S - E_D)}\right]$$

Then, by identifying the population, per capita consumption and elasticities, the total change originated by one person decreasing his/her consumption of animal food product has been calculated.

The following tables sum such calculations by Huang and Lin (2000), Huang (1985), Sumner et al. (2009), Norwood and Lusk (2008), Marsh (1994), Ahn and Sumner (2006), (Norwood & Lusk, 2011) (Table 3.3) and the long run effect of reducing consumption of six animal food products in terms of total production and per capita consumption (Table 3.4). Norwood and Lusk (2011) precise that for crate-free and shelter-pasture pork, 0.74 can be replaced by 0.71 and 0.53 respectively because these production methods may differentiate the products, making them somewhat novel. This will be useful in successive calculations.

The EEAT model can now be put in practice. For instance, let's take an average American who consumes 50.8 lbs/year and assume that he/she might be considering giving up the whole lot. In order to use the EEAT score originated from this decision we have to proceed in several steps.

Table 3.3 Elasticity assumptions behind EEAT

Food item	Demand elasticity	Supply elasticity
Beef	−0.35	0.75
Chicken meat	−0.64	2
Milk	−0.8	1
Veal	−0.9	2
Conventional pork	−0.7	2
Crate free pork	−0.8	2
Shelter pasture pork	−0.9	1
Cage eggs	−0.2	2
Cage free eggs	−0.4	2

Table 3.4 Long run effects of reducing consumption of six animal products

Food given up (1 lb)	Total production final decrease	Per capita consumption of food item/year
Beef	0.68 lbs	65.2 lbs
Chicken	0.76 lbs	85.1 lbs
Milk	0.56 lbs	600.0 lbs
Veal	0.69 lbs	0.5 lbs
Pork	0.74 lbs	50.8 lbs
Egg (one unit)	0.91 lbs	250.0 lbs

Source: Norwood & Lusk (2011)

- *Determine how total consumption will change.* Because of demand and supply elasticity we know that reducing 50.8 lbs of personal pork consumption won't lead to an equally large decrease in production. From Table 3.4 we calculate 50.8 lbs × 0.74 getting 37.59 fewer pound of pork produced.
- *Determine animal well-being.* We need to know how our tested consumer perceive hog's well-being. Since there are both the breeder animal (a sow) and the hog involved and conventional production methods make breeder animals' conditions worse than those of the market animals, let's arbitrarily assume (only for the sake of the example) that our consumer made some researches about factory farms living conditions and came up with a personal score of −8 for the breeder animal and −4 for the market animal.
- *Determine the number of animals affected.* As of Table 3.2 the number of affected for every forgone pound of pork there will be 0.000167336 fewer sows and 0.007195450 fewer market hogs.

- *Calculate the score and put it into perspective*. (−50.8 × 0.74 = −37.59 lbs) × [(0.000167336 sows/lb) × (welfare score for sows: −8) + (0.007195450 market hogs/lb) × (welfare score for hogs: −4) = +0.59. If the score is positive hog well-being is improved by the decision. But furthermore, by comparing different scores for different choices a consumer can see which choice grants more benefits.

Yet, in order to be able to measure human WTP for less cruel production methods we have to compare scores between the same types of food produced in different ways and translate the obtained values into monetary terms. Instead of consuming regular pork, out consumer choses to buy shelter pasture pork, to which he/she attribute well-being score of 4 and 8 for breeder and market animal respectively. This decision's outcomes in terms of animal welfare must be computed as above:

$$(50.8 \times 0.53 = 26.92 \text{ lbs}) \times [(0.000175193 \text{ sows/lb}) \times (\text{welfare score for sows: } 4) + (0.007182901 \text{ market hogs/lb}) \times (\text{welfare score for hogs: } 8) = +1.57$$

Let's assume that this particular person receives a satisfaction from knowing that the animal's welfare is being improved: his/her utility for having the farmers switch to what he/she considers being a more humane production method is 50 (the number can vary according to personal preferences). Then again, he/she experience a disutility giving up 1$: let's say it's equal to 10 (as for the utility, this number varies according to the willingness and ability to part with a dollar).

All things considered, Norwood and Lusk (2011) argue that we can get consumer's WTP by applying the following formula:

$$\frac{(\text{perceived change in animal welfare}) \times (\text{utility from improving animal welfare})}{(\text{disutility from spending \$1})}$$

Holding to the previous assumptions about our consumer's utility and disutility and adding the obtained EEAT scores:

$$\frac{(0.59 + 1.57) \times 50}{(10)} = \$10.8$$

Dividing it for the total number of pounds considered (50.8) we can get the WTF premium for replacing 1 lb of regular pork with 1 lb of shelter-pasture pork: $10.8 / 50.8 lbs = $0.21.
The aforementioned formula implies that people's WTP for more humane food will differ as they have different beliefs and perceptions about the well-being of farm animals raised in different production systems, different levels of utility by knowing that animal well-being is improved and different levels of disutility derived from variances in willingness and ability to part with a dollar. The calculations may be followed also to know the WTP of someone who rejoice from knowing that, by quitting animal products at all, less animals are raised to be food (take for example a vegetarian or vegan consumer which would most certainly apply negative values to all methods of raising farm animals).

For the description of EEAT practical application arbitrary values were used, but they are obviously of little help if we want to hold to real consumers' WTP in order to calculate psychological externalities imposed on American society by livestock rearing. Norwood and Lusk made actual interviews with over 300 Americans about their WTP to reduce the misery and enhance the levels of animal welfare for factory farm animals.

3.3 Measuring human willingness to pay for improved animal welfare

To measure the intensity with which consumers desire improved lives for farm animals, Norwood and Lusk (2011) had to set up a research method which wouldn't be flawed (or, at least, allowed for as few flaws as possible) by typical behavioural bugs people exhibit when expressing WTP not directly by purchasing at the grocery store but through surveys.

The first gap is due to the fact that when people are asked hypothetical questions about their WTP and, therefore, they do not have to put it in action by eventually spending their own, real money, the typical answer is often two to three times higher that what people would actually pay if faced with a purchase decision (List and Gallet, 2001; Little & Berrens, 2004). In other world, to be relevant this kind of research has to discover how consumers actually behave, and not just how they said they would.

Then there is the fact that people usually behave differently in the grocery store and in the voting booth: when people act like citizens they usually tend to think more about ethical outcomes than they would in the market place; when they act like consumers, instead, they tend to think more about what is practical and in their self-interest rather than about what is ethical. This behavioural flaw is also connected to the previous one because when people have to vote as citizens, for instance evaluating a policy which aims to improve factory farm chickens'

condition by banning cage eggs, they do not have to immediately pay a premium for cage-free eggs to vote in favour of cage-free eggs.

A third issue is related to the fact that most consumers in America simply aren't informed enough about modern agriculture and tend to have an idealized, bucolic notion of modern farms. This lack of information makes it difficult for them to consciously express their preferences for animal goods produced under different farm conditions. How consumers' judgement about animal industry varies (and, accordingly, their WTP for improved animal welfare) with the amount of information they have been given access to was already discussed previously in this chapter.

Finally, when participant face a significant cognitive burden (e.g. they are asked to process large amounts of information about different production methods) they may behave in undesirable ways by giving little thought about what they're asked when responding or by adopting an irrational behaviour.

The experiment was set in such a way that these inconsistencies were as mitigated as possible (see Norwood & Lusk for more detailed information about the adopted procedures) so the two economists consider the following numbers to be realistic estimates of the true WTP of the average American consumer for improved factory farm animal conditions.

Table 3.5 Willingness to pay premiums relative to egg from cage system

Egg system	Average premium (per dozen)
Cage-free eggs (barn system)	$0.55
Cage-free eggs (aviary system)	$0.47
Cage-free eggs (aviary w/free range)	$1.06

Table 3.6 Willingness to pay premiums relative to pork chops from a confinement crate system

Farm system producing pork chops	Average premium (per pound)
Confinement pen system (crate free)	$0.16
Confinement enhanced system (crate free)	$1.09
Shelter pasture system	$1.17

Source: Norwood & Lusk (2011)

Take, for instance, the farm level cost of producing cage-free eggs (barn system) which is estimated to be $0.35 more per dozen compared to that of conventional eggs (Sumner et al.,

2008). The simpliest cost-benefit analysis would suggest that, because of the average premium consumers place on these eggs ($0.55), the vast majority of them would still prefer cage-free eggs even after accounting for the additional costs of production. The same can be inferred about free-range system which requires, according to organic producers (Norwood & Lusk, 2011), only $0.05 per dozen in additional costs for providing outdoor space: with the premium per dozen eggs produced under free range system being $1.06, the net benefit would still be such that consumers would be prefered to cage system eggs.

According to Norwood and Lusk, assuming that the demographic profile of the respondents reflects well that of the nation, the average premium can be multiplied by the U.S. population to assess the nationwide WTP for a certain welfare improvement. But before figuring out the final estimate, it's appropriate to make some observations about the estimates which have been left out of the picture.

First, as already mentioned, although estimating psychological externalities through WTP seems, for the time being, like the most accurate way, it necessarily excludes groups who are presumably the most worried about animal welfare: vegetarians and vegans. Because they don't consume fish and meat (vegetarians) or any animal products at all (vegans) their WTP for improved conditions of animals under different production systems is not measurable through the aforementioned method (let alone in the market place) because their answer would most likely be $0 (or, in the market place, because they simply don't purchase such goods). To fix this gap, at least partly, the experiment was enriched by asking the respondents to express not only their private values for animal welfare, but also their public values. Because animal conditions improvements bring satisfaction also to people who, per definition, don't pay for it through animal food purchases, there is a public good dimension to such improvement. This is where the non-excludability of public goods lies: anyone can experience pleasure acknowledging better animal care, even it they did not consume the food or pay for such the improvement. Secondly, public goods are also not rival: the enjoyment someone receives from improving animal well-being does not prohibit others from enjoying the improvement as well.

When participants were asked to measure their WTP for improved animal well-being not only in the products they personally consume, but also in the products they will never consume, they provided the following results.

It's glaring that the value per animal is declining: this result is attributable to several factors. Diminishing marginal utility is among them. Then there are studies showing that humans tend to suffer a size insensitivity problem: they have a built desire to help the single over the many. Researchers found out that people will donate more money to help save 4,500

lives in a refugee camp consisting of 11,000 people than they will give to save the same amount of lives in a refugee camp of 100,000 or that they will donate more money to save one child dying from cancer than they will for eight children in the same condition (per capita) (Norwood & Lusk, 2011). This may also explain why. Nonetheless the final amount is useful for this work's purposes.

Table 3.7 Consumers' willingness to pay for the public value of animal welfare improvement

Number of animals	Average bid
Number of laying hens moved from cage to free range system	
1	$0.98
100	$14.69
1,000	$57.18
All in U.S. (hypothetical)	$341.53
Number of sows and offspring moved from confinement crate to shelter pasture system	
1	$2.85
100	$7.72
1,000	$23.34
All in U.S. (hypothetical)	$345.09

Source: Norwood & Lusk (2011)

The second consideration is that, if we are to estimate the psychological externalities of livestock sector, considering welfare improvement in just two animal farming productions would led us to heavily underestimate the total burden. To attempt to make a picture at least more complete we might want to include also improvements for broilers (which differ from chickens because unlike the latter they are destined to be slaughtered and sold for their meat and not to provide eggs), cows and fish: it would still give a conservative estimate but a more precise one. Laying hens and sows and hogs are very different animals and they bear different, although poor, conditions on factory farms: still consumers' WTP to improve these animals' well-being is similar when it comes to consider all of them, therefore it wouldn't be reckless to assume that by taking the midpoint between the two values ($341.53 and $345.09) we'll get ourselves a good approximation for what consumers would pay to improve also boilers', cows' and fish's lives: $343.31.

As of July 2016, the number of U.S. adults was 249,485,228 (United States Census Bureau, 2017). All previous assumptions holding, every person's WTP to improve the well-

being of animals raised for food is: $341.53 + $345.09 + ($343.31 × 3) = $1,716.55. This figure may seem too high but being proposed as an average it puts us in the right vicinity: some would, or could (and because the experiment was set in such a way that participants were forced to "put their money where their mouth is" their WTP would still be $0, even in the hypothetical framework of a research), spend nothing but how much would a billionaire vegan pay? Moreover, this estimate include still only five cruel practices and doesn't consider numerous others, so if anything, it should be looked at as an underestimation of the real amount of animal welfare related externalities (sustained per capita) translated in monetary terms. The final calculation must include the amortization over 20 years (the standard IRS depreciation for farm buildings) (Simon, 2013) and delivers a figure hard to ignore: 249,485,228 × $1,716.55 = (rounded) $21.4 billion yearly. This amount includes the minimum value Americans would place on enhancing the lives of all farm animals under considered production systems: if consumers also receive a private good benefit also, and we previously noted that they actually do, the total WTP would be even larger. Since we are taking the total WTP as a proxy of the foregone benefits for American consumers, the externalities would increase as well.

Finally, it is worth stressing that, since externalities take place as consequence of market transactions which make the buyer and the seller better off, but harm a third party, trade between livestock producers and animal food consumers actually imposes a cost on a third party: the animal. Externalities deriving from animal suffering occur partly because there is no market for animal well-being and it is not profitable to treat animals compassionately. For our purposes, the human WTP for animal well-being is taken as a best approximation of the externality but we've already seen that, as pioneer methods to measure animal WTP for their own well-being come to light and as approaches allowing to avoid benefit double counting are tested, it's cautious to predict that one day we may be able to make such calculation, potentially soaring the $21.4 billion we came up with earlier.

3.4 Market failures, the role of government and policy challenges

Ultimately we want to understand what's the role of the government in regulating the well-being of farm animals or, even, if it's desirable for the government to have a role at all. Then again, if we end up being inclined to the former, we might wonder under what conditions potential policies and additional regulations are beneficial and when they are harmful instead.
The public dimension of improved animal well-being has already been mentioned. What follows is that the market outcomes of consuming such goods may be less efficient from the standpoint of society as a whole. Let's assume that veal producers decide to improve animal

welfare, but, after testing the new product, found out that consumers are not willing to pay the higher production costs. The improved product is then taken off the market even if there are consumers who are not consuming veal but rejoice from the fact that calves are treated better: if only these other people, who cannot be prevented in their ability to benefit from the improvement, could be charged for such benefit, it would be profitable for producers to enact the enhancement. In this case the normal interaction of buyers and sellers fails to operate in the most desirable way.

Let's now assume that only two people are active in the pork market and there are only two varieties of pork: regular pork and pasture shelter pork. Both believes pasture shelter pork is better, but because pork's well-being improvement is a public good as well as a private one, their purchasing behaviours are related in a typical prisoner's dilemma kind of way, and, therefore, even by making rational decision they are not able to achieve the best outcome without collaborating.

Some argue that market failures call for government intervention: production practice bans appear to be among the most commonly pursued policies in terms of farm animal welfare legislation (Norwood & Lusk, 2011). To fully understand the implication of a production technology ban of any kind we have to acknowledge that such measures are usually promoted by groups of citizens who are informed about livestock issues, but they will primarily impact the uninformed citizenry. According to Norwood and Lusk this is why a policy usually have an informed impact and an experienced impact, the former comprising the costs and the benefits (both private and public) of the ban as appreciated by informed consumers, the latter pertaining to the perception uninformed consumers have of the same measure.

Take the ban on cage-egg production. Unlike informed consumers who are fully aware of the conditions chicken endure under cage system and therefore rejoicing from animal welfare improvement, the only thing uninformed consumers are likely to really understand is the rise of egg prices (which will follow because of the production costs increase). Assuming all citizens are informed and getting down to numbers, by taking the average bid to move 1000 laying hens into cage-free system and safely assuming that he who will pay \$57 to make 1000 hens better off will also pay at least \$57 to make all the 350 million hens (USDA, 2015) better off, the public good benefits for the rounded U.S. population are projected to be \$14.2 billion, while the costs (with \$0.40 per dozen being the additional cost for the free-range system and a total of about 500 eggs produced by a hen over its 2 year life, resulting in an increase per hen by about \$16.67) are estimated to be \$5.8 billion.

In case of informed consumers the public benefits greatly outweigh the costs, but since we know that the WTP is an average estimate they may be unequally distributed across the citizenry. For instance, if the ban benefits only a small part of citizens who are willing to pay very high amounts for animal well-being (making the average WTP much higher than the median WTP), although the total public good benefits exceed the costs, very few Americans would approve of the measure. Therefore, the government should develop a compensation scheme to redistribute benefits from those who feel most compassionately about animal welfare to those who are less motivated: this is theoretically possible but may prove a bureaucratic nightmare because of the practical issues involved with administering such distribution. Even if the winners were to compensate the losers, once they find out how compensational mechanism works they would probably lie about their desire for animal welfare improvement and also feel injustice knowing that they are paying more for a public good than the ones who are compensated.

However flawed because the solution may not be politically feasible at the time being, in this scenario we assumed that consumers were informed. Unfortunately, it's not the case for the average American consumer.

When buyers or sellers have access to more information than the other party, information asymmetries arise, bringing us to the ultimate issue with animal welfare debate: most buyers in America do not know how animals are raised. The research conducted by Norwood and Lusk (2011) shows that consumers have inaccurate perceptions about the livestock industry. For instance, on average, they believe that only 37% of all eggs produced in the U.S. come from cage system: the actual data prove them painfully wrong and indicate over 90% being produced under such system. Also, American consumers believe that 30% of the pork they purchase comes from pasture or organic system, while the actual percentage is lower than 5%.

What American consumers don't know may actually hurt them, and it's not just a figure of speech: Norwood and Lusk calculated the experienced effect of three hypothetical policies improving laying hens and pork welfare, simulating it among uninformed consumers: the two economists came up with an average negative effect of −$4.23 per capita, yearly, for a total −$1.3 billion for the whole population, if the population stays uninformed.

But in light of the evidence that over 70% research participants claimed they were more concerned about the well-being of farm animals after they were briefly informed about the different production systems and that informed consumers, on average, express higher WTP for products produced under systems providing higher levels of animal welfare, in order to mitigate experienced impact due to the dissonance between informed and uninformed consumers, it

would be sufficient to provide Americans with more knowledge. However, what we observed in the first chapter clearly indicate that American government makes all the contrary, instead. Take, for instance, ag-gag laws, enacted in many federal states over the last few years: they purpose is to protect industry from the harmful economic effects that often result when conditions on factory farms are made public, by criminalizing undercover investigations (including recording, possession or distribution of photos, videos or audios). What's left are the official investigations, but we've already seen the related issues: in American animal welfare debate the consumer, who is to choose by making purchase decisions, is deliberately prohibited from accessing authentic information which would help to form such decisions consciously.

This is a market failure identified with the market for lemons problem by Akerlof: in the case of animal products, because it is cheaper to produce animal based foods under low levels of animal care, and because consumers lack the information about such levels, producers have an incentive to only supply food produced under low levels of animal welfare. Since consumers may expect producers to behave like this, they may be sceptic when labels suggest high welfare standards: according to the market for lemons model this leads to the absence of a market with high welfare standards for animal products. But the fact that a market, even if small, exists for products provided under higher animal welfare standards (and, according to Norwood and Lusk, it has doubled its share over the past five years), suggests that information asymmetry problem can be partly overcome.

Apart from providing more information, or, at least, abstaining from passing legislations which persecute journalists and activists who try to do so, to fill the gaps between informed and uninformed consumers, politicians might act out of a sense of paternalism, approving policies which have negative experienced effect with the understanding that if citizenry fully realized the issues with animal welfare they would approve of the regulation. It's not hard to understand that politicians have little incentive to do so, out of fear of being voted out of office by uninformed public which would only witness negative effects. Moreover, with a regulatory capture as huge as the one taking place in U.S. this course of events seems even more unlikely.

Final remarks

This work intended to approach the animal welfare debate from an economic point of view, which would deal with consumers' opinions as mere preferences, disengaging from moral or ethical judgements. Because the public discourse on animal welfare could not exclude animal production activities, these were analysed in terms of supply and demand. A conclusion stemmed from the reasoning conducted in the first chapter suggests that animal-based food consumption may be heavily propelled by supply-side forces, supported by government interventions, and that currently high consumption levels are partly due to uninformed individuals making their purchase decisions.

What triggered this analysis, however, is not the high level of animal products consumption itself, but the fact that consumption is fostered for a sector imposing bulk of negative externalities on American society, a society which, on average, consumes already too much of animal derived foods according to even hugely biased nutritional guidelines.

The negative externalities offloaded by animal agribusiness and industry were classified and discussed, providing monetary estimates of the hidden costs they represent. For some environmental externalities, let alone the so-called psychological externalities, there is no controversy-free way to count the losses and sometimes this is why the related costs are simply neglected. Unfortunately, to ignore such costs at the supermarket cash register won't do much to release us, because they are significant and they ultimately affect us in roundabout ways: even if consumers' wallets don't feel the hit at cash register, it doesn't mean these costs aren't exacted at all.

In the American public discourse about environmental issues connected with industrial activity, when it comes to finger-pointing, the ones many loves to hate are usually tobacco and oil industries. The former, over five decades, was shown to have caused (and ultimately forced to pay) $400 billion in health care costs. According to the latest estimates the U.S. animal food industry spawns more than $600 billion in health care costs every year and "pays virtually none of them" (Simon, 2013). Weird enough, unlike animal agriculture, tobacco sector causes little ecological harm (therefore causing less negative externalities connected to environmental impact) and it's taxed, let alone subsidized.

Oil industry makes itself a rival to animal food sector when it comes to environmental impact: the difference is, most petroleum products in the U.S. are heavily taxed, unlike animal derived goods (Simon, 2013). According to Simon, oil industry enjoys only $10 billion in yearly federal subsidies, including tax breaks: although high in absolute terms, it pales in comparison

to the previously calculated amount of $41.3 billion heaped each year on the animal food industry.

Among other things, this work was thought to be a receptacle for monetary estimates of livestock-related externalities and to prove that attempts to include such costs into retail prices could and should be done. Because concepts like animal willingness to pay are just emerging, it was also argued that it wouldn't be reckless to think that in the foreseeable future economists may figure out a way to combine such estimates with human willingness to pay in order to provide a more complete picture of what now seems a bit abstracted from reality: it's just logical to assume that as more interest is drawn to the debate, concern over, for instance, the treatment of farm animals is unlikely to be a mere fad.

We've seen how, in case of government measures and regulations promoting higher standards of production, the impact may vary greatly across the population, according to the amount of information individuals have about animal industry. But as consumer incomes rise and as fewer consumers have a connection with agriculture, they are more likely to be interested in production processes and repercussions on the environment and on the lives of farm animals as well: within such framework, more calls to increase production standards are something we can reasonably expect.

Moreover, evidence (Kanter et al., 2009) suggests that the mere presence of animal products delivered under improved processes and providing better welfare levels to farm animals is sufficient to lower consumers' willingness to pay for conventional animal products. The study was conducted among consumers of milk whose willingness to pay for conventional milk dropped $0.35-$0.50 per litre when they learned that rBST-free and organic milk were available. These results suggest that as people become informed, they not only might switch to products guaranteeing higher standards, but decrease their overall consumption of animal products as well.

"Most of our beliefs about nutritional needs, consumption levels, and farming and law-making practices are based on traditions that have largely melted away - at a pace of change so slow and seductive, we're barely aware of it." (Simon, 2013), but the consequences of our comfortable unawareness are here to stay until something is changed. The discussed pathways in consumers' behaviour, on one hand, and corrective measures from regulators on the other, are likely to be part of the solution when discussing animal sector negative externalities.

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