Toward Optimal Meat Pricing: Is It Time to Tax Meat Consumption?

Franziska Funke[*], Linus Mattauch[†], Inge van den Bijgaart[‡], H. Charles J. Godfray[§], Cameron Hepburn[‖], David Klenert[#], Marco Springmann[**], and Nicolas Treich[††]

Introduction

Throughout human history, livestock farming and meat consumption have played an important role in both economic development and culinary traditions. Today, livestock farming supports many livelihoods, and in many parts of the world, meat is an important source of protein and micronutrients. However, there is a growing consensus within the environmental research community that the recent global trajectory of meat production and consumption is unsustainable (Machovina, Feeley, and Ripple 2015; Godfray et al. 2018). Livestock farming is significantly more resource intensive than other forms of agriculture. To illustrate, animal-based agriculture and feed crop production account for approximately 83 percent of agricultural land globally and are responsible for approximately 67 percent

[*]Technical University of Berlin, University of Oxford, and Potsdam Institute for Climate Impact Research (email: franziska.funke@pik-potsdam.de); [†]Technical University of Berlin, University of Oxford, and Potsdam Institute for Climate Impact Research; [‡]Utrecht University; [§]Oxford Martin School, University of Oxford; [‖]Smith School of Enterprise and the Environment, University of Oxford; [#]Joint Research Centre of the European Commission; [**]Environmental Change Institute and Oxford Martin School, University of Oxford; [††]University Toulouse Capitole, Toulouse School of Economics, and National Research Institute for Agriculture, Food and Environment

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This article was finalized in the weeks immediately following the Russian invasion of Ukraine. Ukraine is a major supplier of grain for both human food and animal feed, and a number of commodities have already reached prices not seen for decades. Our article does not consider humanitarian and geopolitical arguments for fiscal interventions concerning meat. However, we would expect that if later in 2022 high grain prices are leading to increased hunger in low-income countries, there may be political pressure to tax grain for animal feed or to adopt other measures that would reduce the pressure on grains for human consumption.

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of deforestation (Poore and Nemecek 2018). This makes livestock farming the single largest driver of greenhouse gas (GHG) emissions, nutrient pollution, and ecosystem loss in the agricultural sector. A failure to mitigate GHG emissions from the food system, especially animal-based agriculture, could prevent the world from meeting the climate objective of limiting global warming to 1.5°C, as set forth in the Paris Climate Agreement, and complicate the path to limiting climate change to well below 2°C of warming (Clark et al. 2020).

In high-income countries, high levels of meat consumption also pose significant risks for public health. The World Health Organization has declared processed meat as carcinogenic and unprocessed red meat as likely carcinogenic, and there is evidence that meat-heavy diets increase the risk of coronary heart disease, stroke, and type 2 diabetes (Godfray et al. 2018). In its current form, livestock production also increases the risks to public health from zoonotic diseases (Espinosa, Tago, and Treich 2020) and antimicrobial resistance (O'Neill 2016).

These negative environmental externalities and health effects of meat are currently not reflected in retail prices and have remained largely unaddressed by policy makers. The lack of regulatory attention to meat is especially striking given the progress that has been made in other major polluting sectors, such as electricity and transportation. For example, even though approximately 13 percent of global GHG emissions are due to livestock farming (Poore and Nemecek 2018), carbon pricing policies generally exclude the sector. Several factors may explain why meat has been largely ignored by regulators. First, the economic entities involved (typically farm businesses) are much smaller and emissions sources are more heterogeneous than in other sectors; this makes it difficult to implement policies because monitoring and transaction costs are high. Second, cost-effective production-side measures to align industrial livestock farming with environmental goals are likely limited, with potential breakthrough solutions like alternative protein technologies in only the very early stages of development and deployment. This suggests a stronger role for demand-side abatement (e.g., taxes on meat consumption). However, such policies are likely to be strongly opposed by stakeholders in the livestock sector. Finally, meat consumption has a strong cultural component, prompting concern that consumers will strongly oppose higher meat prices.

The prospects for more stringent regulation of meat in high-income countries have improved recently because of the requirements of a net-zero carbon transition as well as calls for "building back better" after the COVID-19 pandemic. From an environmental economics perspective, the appropriate pricing of meat (which reflects its social costs) should be at the core of such regulation.[1] Clearly, a tax on meat is not a "first-best" option and would indeed be unnecessary if appropriate prices on carbon and other externalities were in place. However, in the absence of such first-best policies, the strategy of targeting meat (or possibly meat and dairy) as a high-polluting food category is supported by environmental research.[2] The environmental impacts of most animal products are much higher than those of plant-based

[1]Our focus here is on regulating meat consumption by raising the price of meat, especially through consumption taxation. Nonpricing interventions to decrease meat consumption directly include bans (such as meat-free days in public institutions) and behavioral instruments or "nudges" (such as vegetarian defaults). For a discussion of such nonprice regulation, see, e.g., Bonnet et al. (2020) and Meier et al. (2021). Direct regulation of farming practices, which can contribute to mitigating the environmental impact of meat production, is briefly discussed below.

[2]For simplicity, we do not consider dairy products. However, we note that appropriate dairy pricing should be a priority for research. Some of our theoretical conclusions may also apply to the dairy context.

products (Poore and Nemecek 2018), and research indicates that carbon taxes on plant-based foods would be close to zero (Springmann et al. 2017). Indeed, regulators appear to be increasingly receptive to the idea of raising meat prices. In the United Kingdom, for instance, some government officials have been discussing targeting carbon taxes specifically to meat and dairy as high-carbon goods (Helm 2021).

This article examines the potential use of consumption taxes on meat in high-income countries to address the negative environmental and health-related externalities of meat. Consumption taxes would alleviate concerns about the competitiveness impacts and high monitoring costs associated with imposing taxes at the source (i.e., at the livestock farm level). Moreover, when targeted externality-correcting policy instruments across the entire agricultural sector are unavailable, meat taxes provide an attractive second-best alternative because they can help to achieve multiple policy objectives aimed at livestock farming and meat consumption. In environmental economics, this logic is analogous to imposing a tax on transportation fuel, which also simultaneously addresses many externalities, including air and noise pollution, climate change, and congestion (Parry and Small 2005). Unlike optimal fuel pricing, there has been little research on economically efficient policies for regulating meat in a second-best context (i.e., in the presence of additional uncorrected market failures and economic distortions).[3] Indeed, with the exception of Bonnet et al. (2020) and Katare et al. (2020), previous environmental economics research on this issue has focused predominantly on single categories of externalities (e.g., Wirsenius, Hedenus, and Mohlin 2011). This article seeks to fill this gap by providing policy makers with guidance on how to approach meat regulation in the presence of multiple externalities and regulatory challenges.

The remainder of this article is organized as follows. The next section reviews the empirical evidence on the "social costs of meat." We find that meat is currently significantly underpriced, with the external costs of beef due to its impacts on climate change and nutrient pollution adding up to on average US$5.75–US$9.17 per kilogram. Accounting for biodiversity loss and diet-related health impacts would further increase costs substantially. The third section examines the case for taxing meat from a public economics perspective. More specifically, we assess several key elements from public, behavioral, and welfare economics that motivate regulatory efforts to tax meat: (1) the interaction of multiple environmental externalities, (2) "alternative protein" technologies, (3) the adverse effects of meat consumption on one's own health (health internality), (4) animal welfare, and (5) distributional effects. In the penultimate section, we discuss the political economy of consumption taxes on meat. While at this time, we cannot draw conclusions about the optimal second-best tax rate for meat products, our results can help to inform future economic modeling studies. We also argue that the design of optimal meat taxes depends on normative concerns such as animal welfare and distributional impacts. In the final section, we present conclusions and highlight priorities for future research in this area.

[3]In fact, in a detailed literature review conducted on August 13, 2020, in which we searched for optimal meat taxation by "(meat OR animal OR livestock OR beef OR pork OR poultry) AND (tax* OR pric*) AND (social cost* OR Pigou* OR optimal* OR efficien*)" across RePEc IDEAS and Google Scholar, we identified only six articles (from among the first 100 entries) that were directly relevant from a public economics perspective.

Empirical Evidence on the Social Cost of Meat

Pricing meat appropriately (i.e., to reflect its social costs) requires an assessment of the environmental externalities and health effects from livestock farming and meat consumption. This section reviews the empirical evidence and progress on the economic valuation of the environmental externalities and diet-related health impacts associated with meat production and consumption. Although large-scale global health threats such as zoonotic disease emergence (Jones et al. 2013) and antimicrobial resistance (O'Neill 2016), as well as concerns about animal welfare (discussed below), also provide a rationale for more stringent livestock regulation, our focus here is on the evidence concerning those environmental externalities and diet-related health impacts for which there are robust empirical estimates.[4]

Evidence on Environmental Externalities

Given the availability of farm-to-fork environmental impact assessments that rely on life cycle analysis, there is robust empirical evidence on the links between meat products and environmental outcomes (Poore and Nemecek 2018). At the global level, the main environmental externalities from livestock farming are (1) climate change, (2) nutrient pollution and air pollution, and (3) biodiversity loss. More specifically, meat production contributes to climate change through the emission of methane (from digestive processes in ruminants and manure storage), nitrous oxides (from fertilizer application and manure processing), and carbon dioxide (from feed-related direct land-use changes and energy use; Gerber et al. 2013). Nutrient pollution, in the form of ammonia, nitrogen oxides, nitrates, and organic nitrogen, causes soil acidification, eutrophication of oceans (i.e., damaging nutrient enrichment that can lead to dead zones), and freshwater pollution (Uwizeye et al. 2020). Through ammonia emissions and particulate matter from animal manure, the livestock sector is also a significant contributor to local air pollution, causing respiratory health issues in agricultural workers, local residents, and the general public (Lavaine, Majerus, and Treich 2020). Biodiversity loss from livestock farming is largely driven by land-use change (FAO 2019).[5]

Social costs from climate change and nutrient pollution

Figure 1 presents estimates of the economic value of environmental damages from different meat types. We arrived at these estimates by combining average environmental impacts with social cost estimates for GHG emissions and nutrient pollution. Average environmental impacts per kilogram of meat were derived from a meta-analysis of life cycle assessments from approximately 38,000 farms worldwide (Poore and Nemecek 2018). For the social costs of carbon, we used a central value of US$100 per ton of CO_2 equivalent. For the social costs of eutrophication and acidification, we used European Union–specific estimates with a central

[4]It is important to note that our discussion of the social cost of meat is different from that of the well-known social cost of carbon because (1) the latter refers to an additional marginal unit, while our numbers are averages; (2) meat production causes pollutants, but meat itself is not a single (homogeneous) pollutant; and (3) the social costs of meat can include private health costs that are not internalized (i.e., accounted for) by individuals.

[5]Under certain conditions, animal farming can have positive externalities—e.g., through carbon sequestration from grazing. Globally, however, these positive effects are far outweighed by the negative impacts (Garnett et al. 2017; Godfray et al. 2018).

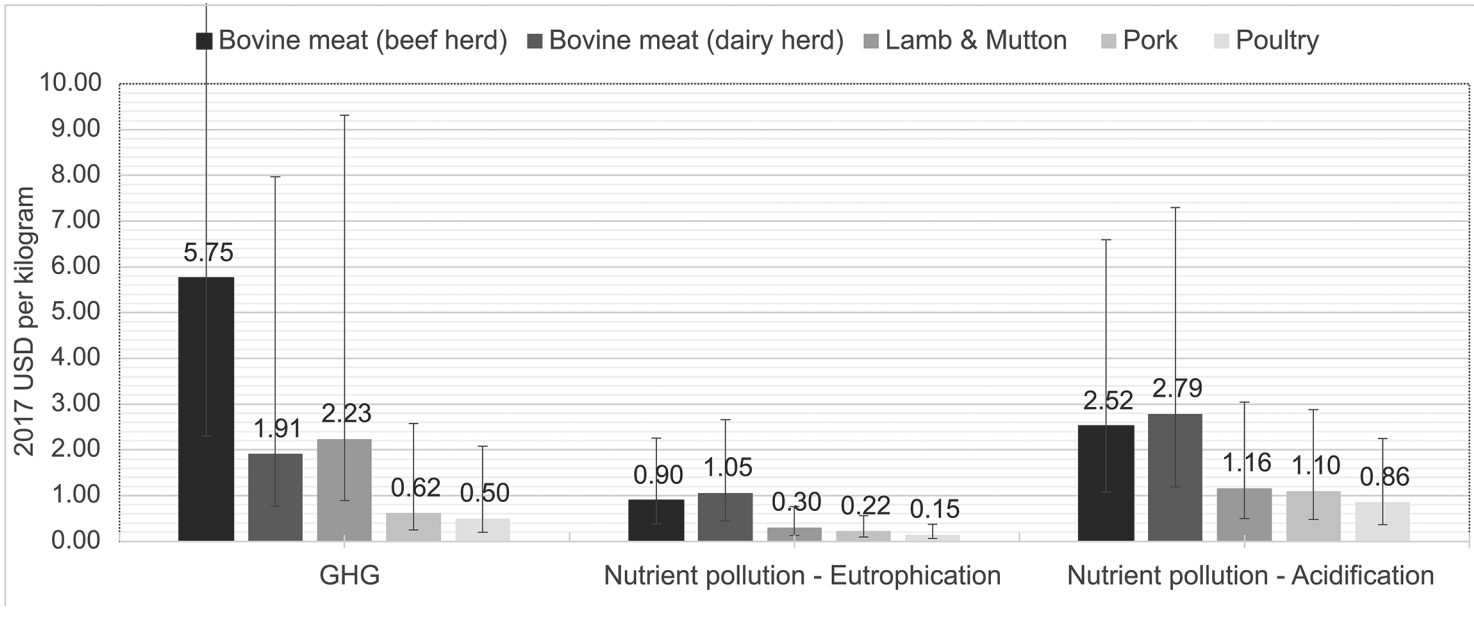

Figure 1 Estimates of the social costs from climate change and nitrogen pollution for selected meat types (in US dollars per kilogram); sufficient data on biodiversity currently not available. For the detailed methodology, see S1 in the appendix. Source: Based on Poore and Nemecek (2018). A color version of this figure is available online.

value of US$5 per kilogram of PO_4 equivalent for eutrophication and US$13 per kilogram of SO_2 equivalent for acidification (Brink et al. 2011; CE Delft 2015).[6]

Social costs from air pollution and biodiversity loss

Because of a lack of data, we did not include damages to human health from livestock-related air pollution and damages related to biodiversity loss in the estimates. The difficulty of obtaining estimates of the social cost of biodiversity impacts from livestock stems from a lack of both impact assessments (e.g., in life cycle analysis) and robust economic valuations of biodiversity loss at global and local levels.[7] Nevertheless, a growing body of economics and environmental science research asserts that the economic value of natural ecosystems is immense and that transforming or reducing livestock farming plays an important role in maintaining biodiversity (Dasgupta 2021). Indeed, using a model of the optimal expansion of agricultural land, Lanz, Dietz, and Swanson (2018) find that a moratorium on further land conversion is socially optimal based solely on the negative effect of biodiversity loss on agricultural productivity. In practice, the associated social costs will actually be much higher once the total economic damage from destroyed ecosystems is included.

Results

Our review of the empirical evidence indicates a lower bound on total average global environmental external costs of US$5.75–US$9.17 per kilogram for beef (depending on the production of dairy by-products), US$3.70 per kilogram for lamb and mutton, US$1.94 per kilogram for pork, and US$1.50 per kilogram for poultry (see figure 1). This is a conservative estimate because it does not include the external cost of the resulting biodiversity loss and the health effects from livestock-related air pollution. The average retail price for beef in high-income countries in 2017 was US$16.53 per kilogram (US$10.49 per kilogram for pork, US$19.04 per kilogram for lamb, and US$6.15 per kilogram for poultry; World Bank 2020). Thus, the evidence suggests that (ignoring interaction effects) an environmental tax on meat in high-income countries would increase its current retail price by roughly 20–60 percent, depending on meat type.[8]

Evidence on Diet-Related Health Impacts

In high-income countries, the detrimental health impacts of some meats, particularly red meat (which includes beef, lamb, and pork) and processed meat (which includes bacon and sausages), have been well established. In fact, on the basis of epidemiological evidence and an understanding of the underlying causal mechanisms, the World Health Organization has declared processed meat carcinogenic and unprocessed red meat likely carcinogenic to humans (Bouvard et al. 2015). There is also moderate to strong evidence from meta-analyses of epidemiological studies that red and processed meat increases risks for coronary heart disease, stroke, and type 2 diabetes (Schwingshackl et al. 2017; Bechthold et al. 2019). However,

[6]See S1 in the appendix (available online) for our detailed methodology.
[7]See S1 in the appendix for details.
[8]This is only a "ballpark" estimate because, as discussed below, optimal taxation theory requires careful consideration of interaction effects when modeling tax levels.

the effects of unhealthy diets on the individual are not an externality because they are a form of self-inflicted harm. Nevertheless, health impacts can affect macroeconomic outcomes. For example, the diet-related health consequences of meat consumption can indirectly lead to productivity losses. In addition, in countries with universal health-care coverage, where costs are collectivized, such risks increase the cost of the public health system.

Figure 2 presents the costs associated with diet-related health impacts in high-income countries and globally based on the consumption of one additional serving of meat per day.[9] The valuation of the private costs of meat consumption is based on the value of statistical life (VSL; see figure 2*A*),[10] which can be viewed as a measure of the privately incurred harms from meat consumption (Springmann et al. 2016; Springmann 2020). In contrast, the cost of illness approach (see figure 2*B*) captures the direct and indirect costs associated with treating a specific disease, including medical and health-care costs (direct) as well as the costs of informal care and lost working days (indirect; Springmann et al. 2016, 2018).

To summarize, we find that the health-related social costs from high levels of meat consumption are significant, with the value of privately incurred harms from meat consumption (figure 2*A*) estimated to be one to two orders of magnitude above the economic costs of illness (figure 2*B*). If the valuation of privately incurred health effects is included, the environmental tax on unprocessed beef would approximately triple.[11]

The Public Economics of Meat: Rationales for Consumption Taxes on Meat as a Second-Best Instrument

Although the external costs from livestock-related environmental damages and health effects are significant, these costs have remained largely unaddressed by fiscal policy. Currently, in most countries, the only taxes on meat are value-added taxes (VATs), often at reduced rates. Undoubtedly, the most efficient (i.e., first-best) way to regulate livestock farming and meat consumption, as well as other forms of agricultural production and food consumption, is to impose targeted externality-correcting instruments such as carbon pricing, nitrogen regulation, and ecosystem valuation. In the absence of such first-best options, meat taxes can help mitigate many of the market failures and regulatory challenges of livestock production and meat consumption. The "optimal" tax level on meat depends on which externalities and other regulatory objectives are to be addressed. For example, optimal consumption taxes generally contain a Ramsey taxation element for the general purpose of raising public revenue. Economic efficiency dictates that this Ramsey tax should be higher for inelastic goods than for elastic goods. The optimal tax level also depends, in part, on specific (and perhaps less familiar) normative positions, such as those concerning animal welfare and health improvement. Moreover, in imperfectly regulated markets, it is important to design meat taxes with any remaining uncorrected distortions in mind.

[9]We excluded obesity as a potential detrimental health impact of high meat consumption because the epidemiological studies that are used to track dietary risk factors of meat consumption generally focus on dietary composition while keeping energy intake constant.

[10]VSL is commonly used in benefit–cost analyses to convert lives saved from healthier diets to dollar amounts. The measure is based on the willingness to pay for a reduction in mortality risk (OECD 2012).

[11]For methodological details, see S2 in the appendix.

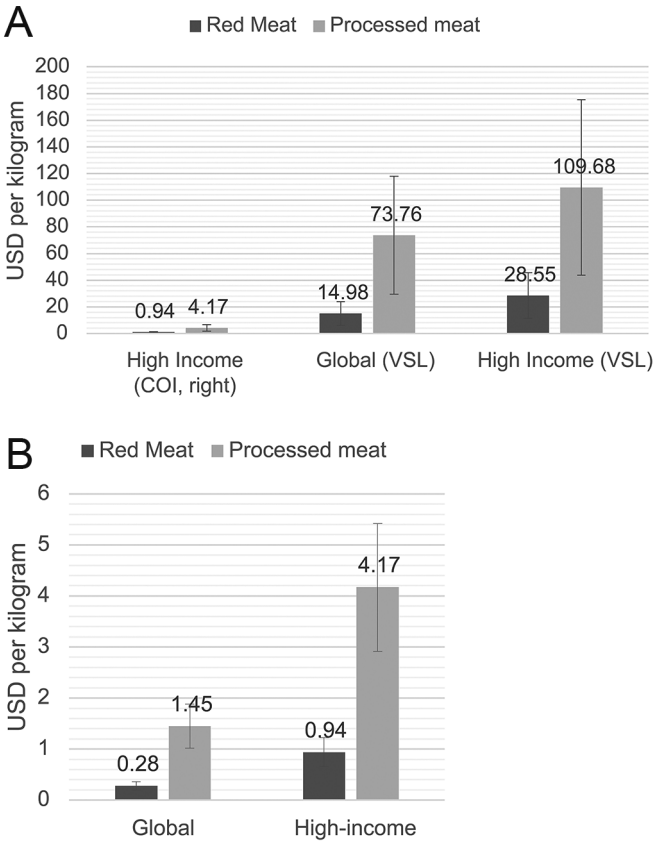

Figure 2 Diet-related health costs per kilogram of meat consumed. COI = cost of illness. Sources: Springmann et al. (2016, 2018); Springmann (2020). A color version of this figure is available online.

In the remainder of this section, we examine key issues in the design of a meat tax, including remaining uncorrected market failures and normative motives for taxing meat that go beyond correcting environmental externalities.

Interaction of Multiple Environmental Externalities

Economic theory asserts that when regulating a set of simultaneously occurring, overlapping distortions and inefficiencies, the optimal policy response is generally different from the sum of its parts. That is, in the presence of at least one persistent uncorrected distortion, any attempt to combine standard first-best policies is not guaranteed to increase welfare (Lipsey and Lancaster 1956). In practice, this means that the optimal tax rate may deviate from the sum of external costs (see figures 1, 2). As we will discuss below, this point generally holds for multiple market failures and inefficiencies in meat production and consumption.

To illustrate, consider two prominent environmental externalities of livestock farming, GHG emissions and nutrient pollution. In this case, a tax on GHG emissions from livestock that fully corrects the GHG externality will have the cobenefit of reducing local nutrient pollution. In other contexts, such as optimal fuel taxation, it has been shown that a tax that equals the sum of the external costs for both local pollution and GHG emissions will be suboptimally

high (Parry and Small 2005). Yet despite much quantitative work on the cobenefits of climate change mitigation, there has been little research on second-best interactions between GHG emissions and local environmental pollution from livestock farming.

Furthermore, what environmental science refers to as "indirect land-use effects" may have a significant effect on optimal meat tax design. Animal-based products account for 83 percent of all agricultural land use and are a significant driver of deforestation (Poore and Nemecek 2018). This means that increasing or decreasing meat consumption will have a general equilibrium effect on global land markets, which will increase or decrease pressure on other forms of land use (e.g., arable farming for human consumption). Such land uses are significant drivers of deforestation and biodiversity loss (Hertel 2018). These indirect effects are an important second-best consideration because they would not be relevant if there were complete, optimally regulated global land and water markets where appropriate scarcity-weighted prices could unlock unrealized conservation opportunities. However, existing instruments used in these markets, such as the international REDD+ scheme for forest protection, are insufficient in both ambition and coverage.[12] For this reason, livestock farming will likely continue to contribute to deforestation, biodiversity loss, and water scarcity in many parts of the world, including in vulnerable regions such as rain forests (Godfray et al. 2018). This suggests that attempts to model an optimal tax rate on meat must account for both potential synergies when regulating environmental externalities and interaction effects with unregulated adjacent resource markets.

Development and Adoption of Alternative Protein Products

A reduction in the consumption of meat is likely to be accompanied by a shift to meat substitutes, which generally have less environmental impact, especially when they are plant based (Smetana et al. 2015). There is a large variety of such substitutes, ranging from unprocessed foods such as beans or lentils to more processed plant-based products (meat analogues) such as tofu and Quorn to novel products such as lab-based, or "cultured," meat.[13] Over the past decade, continued innovation has allowed for the commercialization of a larger variety of meat analogues, many of which closely resemble meat, such as the "Beyond" and "Impossible" burgers. The first proof of concept of cultured meat was showcased in 2013: a burger reputed to have cost more than US$280,000 to develop (Rubio, Xiang, and Kaplan 2020). Although costs have decreased substantially, there continues to be much uncertainty about the potential for—and costs of—mass production and consumer acceptance (Treich 2021).

By further encouraging the adoption of meat substitutes, a meat tax can serve as an indirect alternative to higher R&D subsidies, which will accelerate the development and commercialization of cultured meat and meat analogues. There are several justifications for setting meat taxes above the Pigouvian level to encourage innovation. First, evidence from other fields suggests that innovation spillovers are particularly high for novel products (Dechezleprêtre, Martin, and Mohnen 2013) and in R&D-intensive industries (Bloom, Schankerman, and Van

[12]This is a framework created by the United Nations Framework Convention on Climate Change to enable payments to reduce emissions from deforestation and forest degradation.

[13]The terminology for these innovations is still evolving and depends on the narratives and motives of different stakeholders. The academic literature has largely converged on the more neutral and broad term "alternative proteins," which we use alongside "meat substitutes" here (Sexton, Garnett, and Lorimer 2019).

Reenen 2013). Second, the development of cultured meat and meat analogues makes a durable shift away from meat more likely. In addition to providing cheap and desirable alternatives to meat, support for innovation in meat substitutes can serve as a commitment device for policy makers (i.e., future policy makers will be more likely to impose meat taxes when low-cost alternatives are available; Harstad 2020). Conversely, in the absence of an externality-correcting price for meat, there is a rationale for subsidizing the consumption of—and R&D on—meat substitutes.[14]

Meat taxes can encourage the consumption of alternative protein products by making them more competitive with conventional meat products. However, the success of meat alternatives will depend to a large extent on the degree of substitutability between meat and alternative protein products, with those that are cheap and have the taste and "mouthfeel" of meat more likely to gain the largest market share (Carlsson, Kataria, and Lampi 2021). Moreover, the public perception of meat alternatives is important. This includes whether alternative protein products are perceived as "wholesome" or "natural" and whether the consumption of meat has a strong cultural component that alternative proteins may not be able to replace. Cultured meats may eventually fare better in terms of the cultural component. Meanwhile, unprocessed plant-based protein sources are already readily available and associated with both health benefits and low environmental impacts (World Economic Forum 2019).

Health Internalities

A growing body of literature in behavioral economics suggests that consumers do not adequately account for the health risks of eating unhealthy food such as large quantities of meat, which results in long-term internalities (adverse effects on one's own health) from diet-related disease (Griffith, O'Connell, and Smith 2018; Allcott, Lockwood, and Taubinsky 2019).[15] Correcting for these uninternalized health-related costs is another potential rationale for higher taxes on meat. There are several real-world precedents for such corrective taxes. Governments around the world have imposed taxes on products that are widely recognized as threats to public health, including tobacco, alcohol, and sugary beverages. In perhaps the most relevant example, Denmark introduced a tax on saturated fats in 2011,[16] which led to a significant reduction in demand for selected meat products (Jensen et al. 2016). However, nutritional studies have found that the health impacts of such taxes critically depend on cross-price elasticities of demand (Mytton et al. 2007), suggesting the need to carefully target health-motivated meat taxes to avoid encouraging consumers to substitute other unhealthy products for red and processed meat.

Treating the negative health effects of meat-heavy diets as an internality that merits governmental intervention reflects a distinct normative position that must be carefully justified. Specifically, the argument for regulating unhealthy foods is based on the premise that individuals' dietary choices do not maximize individual welfare. This will occur when the risk of

[14]This is analogous to providing second-best subsidies for low-carbon technologies in the absence of adequate carbon pricing (Kalkuhl, Edenhofer, and Lessmann 2012).

[15]Such simultaneous market and consumer behavior failures pervade many environmental economics issues. Thus, meat consumption is another example of an environmental-behavioral second-best problem (Shogren and Taylor 2008).

[16]The tax was repealed in 2013.

diet-related disease is not sufficiently known to consumers (incomplete information) or not sufficiently considered when making dietary choices. Behavioral economists have demonstrated that people's diet-related choices can be affected by numerous behavioral factors, including lack of willpower and projection bias (i.e., the belief that dietary preferences and health conditions remain stable over time; Griffith, O'Connell, and Smith 2018). Perhaps most importantly, dietary choices are often time inconsistent; that is, people ignore or disproportionately discount their long-run health preferences in favor of immediate gratification, thus generating costs for their future selves that are not fully appreciated when consuming meat (O'Donoghue and Rabin 2000). A crucial question for policy design is whether such "behavioral failures" justify governmental correction, as is the case with market failures.

In welfare economics, treating behavioral biases like market failures requires relaxation of the standard conception of welfare as utility maximization based on revealed preferences—that is, the notion that people are best off with what they actually choose (Bernheim and Rangel 2009). Moreover, some policy makers may justify governmental intervention concerning meat (over)consumption on the basis of alternative notions of welfare, such as long-run subjective well-being ("happiness") or context-specific regulatory objectives for public health (Fleurbaey and Blanchet 2013).

If we take the position that health internalities should indeed be corrected, we can turn to the public economics literature for several proposals concerning the optimal design of corrective taxes in the presence of health internalities (Griffith, O'Connell, and Smith 2018; Allcott, Lockwood, and Taubinsky 2019; van den Bijgaart et al. 2020). Assuming that these findings are transferable to meat taxation, we would expect that the second-best tax rate on meat increases with the magnitude and pervasiveness of internalities in the population and the responsiveness of consumers to meat price changes. Furthermore, such internality taxes on meat could be increased for distributional motives if low-income households exhibit stronger diet-related behavioral failures and are more responsive to price changes relative to the rest of the population (Allcott, Lockwood, and Taubinsky 2019).

Regardless of one's position on the normative question of correcting internalities, behavioral biases in dietary consumption choices clearly complicate the regulation of meat. Such biases may also affect the success of taxation in changing food choices, suggesting a need for additional non-market-based interventions.

Animal Welfare

There appears to be a broad consensus in most societies that animals reared for human consumption should not suffer high levels of pain or distress prior to and during slaughter. Indeed, calls for stricter animal welfare standards have increased in recent decades, especially in high-income countries, while ethical opposition to consuming meat is one of several reasons for the (modest) increase in the number of people identifying as vegetarians or vegans. Although animal science is increasingly able to define and measure physiological proxies for welfare, the issue of animal welfare is particularly complex because a full understanding of the nature of animal emotions and cognition has remained quite elusive (Dawkins 2012; Broom 2014).

Although there is evidence that many people are concerned about animal welfare and willing to pay a premium for more humane rearing conditions (Clark et al. 2017), in the

absence of regulation, the market is likely to provide a level of animal welfare that is lower than what society desires. There are several reasons for this. First, consumers may not have access to point-of-sale information about the welfare status of different meat types, and where welfare labeling exists, they may not have the time or ability to act on it or may not trust it. Second, consumers concerned about overall standards may be unwilling to pay a price premium for high-welfare meat if there is free riding by others. Finally, there is a gap between consumers' stated preferences and their actual purchase decisions (Grethe 2017). There is evidence in the psychology literature that consumers exhibit cognitive dissonance; that is, they claim to support high welfare standards but buy cheap meat (Bastian and Loughnan 2017). Thus, one possibility for ensuring a higher standard of animal welfare would be for society to regard animal welfare as a public or "merit good" (Besley 1988),[17] which would justify government intervention to ensure better standards of livestock husbandry.

Beyond the public debate on animal welfare, philosophy researchers have long argued that animals have intrinsic value and hence that their treatment should not depend solely on humans' preferences (Bentham 1780; Singer 2011). This raises the question of whether and how to integrate the well-being of animals directly into the social welfare function. However, extending the methods of social welfare analysis to nonhuman animals remains a challenge for animal behavioral science because it needs to be based on theory concerning how to compare well-being or different welfare criteria across species (Fleurbaey and Leppanen 2021). Despite these challenges, the welfare economics literature includes proposals for incorporating animal welfare into a multispecies utilitarian social welfare function (Blackorby and Donaldson 1992; Johansson-Stenman 2018). Incorporating policy instruments such as meat taxes into these types of models is one important direction for future research.

What are the implications of setting meat taxes for animal welfare in practice? First, meat taxes generate fiscal revenue, a part of which could be redistributed to livestock farmers to help them improve rearing conditions.[18] Second, there is evidence that higher meat prices can help correct consumers' cognitive dissonance when buying meat (Hestermann, Le Yaouanq, and Treich 2020); this is because higher prices lower the returns from self-deception about standards for animal welfare and thus increase the price elasticity of meat demand. However, meat taxes, especially when they are designed with other objectives in mind, such as addressing environmental externalities, may entail substitution effects that are actually detrimental to animal welfare (such as when price increases prompt consumers to switch from free-range meat to products raised under inferior rearing conditions). Finally, higher meat prices will lead to lower aggregate meat demand and thus affect the size of farm animal populations. This means that the welfare effects of meat taxation will depend crucially on how the change in animal populations is evaluated from the perspective of population social choice.[19] Whether a tax-induced change in farm animal populations is socially beneficial thus depends on whether a farm animal life is determined to be "worth living" (Espinosa and Treich 2020).

[17]Merit goods are commodities that society deems desirable but are underprovided by the market.
[18]This was recently discussed in Germany as an "animal welfare levy."
[19]This is the branch of welfare economics and ethics that studies the moral value of additional lives. See S3 in the appendix for details.

Distributional Effects of Meat Taxation

A frequent concern raised about a meat tax is that the tax burden will fall disproportionately on low-income households because they spend a larger share of their income on food. This section discusses the potential distributional impacts of meat taxes and how they can be designed to minimize their effects on low-income households.[20]

The fact that relative spending on food falls with rising income (also called Engel's law) is one of the most verified relationships in economics and has been a key argument underlying reduced VAT rates on foodstuffs in many countries. Indeed, empirical studies have shown that for most European countries and for the United States, the relationship between relative meat expenditure and income has followed this pattern, suggesting that low-income households will be disproportionately burdened by meat taxes (Bureau of Labor Statistics 2020; Klenert, Cai, and Funke 2021).[21]

The distributional effects of meat taxation will depend on both the responsiveness to higher meat prices at different incomes and how households allocate their expenditure across different meat types. It is important to note that the impact of meat taxes will differ from the impact of many other environmental taxes because consumers can immediately substitute away from the taxed goods without major investments or suffering adverse effects. This implies that meat taxes will lead to a stronger decrease in meat demand compared with, for example, the demand response to fuel taxes (Brons et al. 2008; Gallet 2010). Moreover, as demand for meat becomes less elastic with rising income (Femenia 2019), low-income households will reduce their meat consumption more than high-income households.

In addition, if meat taxes are differentiated by meat type—for example, on the basis of GHG emissions intensity—the tax burden will rise as more meat types with high external costs (e.g., beef) are consumed. Indeed, Klenert, Cai, and Funke (2021) find that for European Union countries, relative expenditure patterns for different meat types vary significantly. For instance, in France, a meat tax based on GHG emissions intensity would most affect the three middle quintiles because they spend a larger share of their expenditure on beef than the lowest and highest expenditure quintiles.

The potential regressive impact of meat taxes raises the question of how policy makers can alleviate the burden on low-income households. A frequent finding of optimal environmental taxation models that feature heterogeneous households is that externality taxes should not be corrected for their distributional impact because the impact is better offset through the tax and transfer system (e.g., by lowering income taxes; Jacobs and de Mooij 2015). However, when income taxes are not optimal or cannot be easily adjusted in response to the introduction of meat taxes, adjusting the meat taxes to achieve distributional goals may be justified (Sandmo 1975; Jacobs and van der Ploeg 2019).

Moreover, research on environmental taxation suggests that revenue recycling can make meat taxation more progressive. More specifically, if relative spending on a good decreases with income but spending increases overall, taxing this good and returning the revenue as per

[20]We focus here on partial equilibrium effects (i.e., shifts in the consumption of meat products) and the distributional effects of redistributing meat tax revenues. A complete assessment of the distributional consequences of meat taxes would also account for general equilibrium effects (e.g., effects on the labor market).
[21]See S4 in the appendix for details concerning meat expenditures in the European Union.

capita lump-sum payments will be progressive (Klenert and Mattauch 2016). This suggests that the most straightforward way to balance the potentially regressive initial distributional effects of a meat tax is through the uniform lump-sum redistribution of the revenue (Rausch, Metcalf, and Reilly 2011). If such a measure is not politically feasible, then using the revenue to further reduce the VAT rate on food or to subsidize fruit and vegetables (Springmann et al. 2017) would also be progressive; however, further research is needed to determine whether this would fully offset the initial regressive impact of the tax.

How Do Second-Best Interactions Affect the Optimal Tax Rate on Meat?

Although the extent to which the economic distortions discussed above affect the optimal tax rate on meat is a topic for future research, we can draw some preliminary conclusions about the anticipated direction of these effects (see table 1). In a second-best setting, we assume that the synergies from meat taxation will increase the optimal tax rate. In contrast, when meat taxes exacerbate uncorrected market failures or normative concerns, we would expect optimal tax rates to be lower.

Table 1 Potential principal components of a tax on meat and their anticipated effects on second-best tax levels

Potential component of a tax on meat, relevant effect	Anticipated impact on the tax rate (+/– relative to baseline)
Baseline: environmental damages (naive tax rate, which ignores interaction effects)	
Sum of social costs from climate change, nutrient pollution, and biodiversity loss	
Environmental second-best interactions	
Livestock farming entails indirect land-use and water-use effects on suboptimally regulated resource markets	+
Health internality (i.e., privately incurred health damages from eating too much meat)	
Consumers display behavioral failures in food choices	+
Consumers may react to higher meat prices by substituting toward other unhealthy products	–
Animal welfare	
Higher meat prices lower returns to self-deception with respect to animal welfare, crowding in social preferences	+
Higher meat prices decrease farm animal populations; welfare effect depends on whether additional animal lives are worth living under respective rearing conditions	+/–
Indirect support for "alternative protein" technologies	
There are uncorrected innovation-related market failures for alternative protein technologies	+
Distributional concerns	
Tax incidence falls disproportionately on poorer households	–
Meat tax is complemented by progressive revenue recycling	+
Health benefits from taxing meat fall on poor households	+
Ramsey tax component	
Fiscal revenue generation	+

Discussion: The Political Economy of Consumption Taxes on Meat

When designing regulations for the livestock sector, policy makers need to carefully consider the trade-offs between complexity and simplicity and between efficiency and feasibility. In this section, we discuss the suitability of second-best consumption taxes on meat in light of these trade-offs. First, we consider the advantages and disadvantages of consumption taxes relative to taxing farm-level pollution directly. Then we discuss the issue of how to best implement meat taxes while also considering the needs and preferences of meat producers and consumers.

Is a Tax on Meat Consumption Justified?

Ideally, on the basis of the logic of optimal policy design, meat taxes should be consistent with pollution at the source. This ensures that taxes will most efficiently incentivize abatement along the supply chain and that tax burdens will be distributed in accordance with the polluter pays principle. However, because (compared with other polluting industries) farm-level entities in the livestock sector are comparatively small and scattered, monitoring costs for farm-specific pollution and animal rearing conditions are high. In contrast, second-best consumption taxes require less monitoring effort and are relatively simple to implement.

Indeed, Schmutzler and Goulder (1997) show that in the presence of high monitoring costs, consumption taxes may be more efficient than first-best policy instruments if production-side abatement options are limited and the taxed goods can be easily substituted. For the climate externality specifically, there is evidence that the potential for decarbonizing traditional livestock farming is ultimately limited and in a net-zero world would require negative emissions in another sector (Wirsenius, Hedenus, and Mohlin 2011; Clark et al. 2020). Demand-side solutions (e.g., consumption taxes) can also be justified on the basis of objectives other than mitigating climate change: protecting biodiversity and halting deforestation imply that agricultural land expansion is infeasible. Given this constraint on further land conversion, combined with growing demand for animal products in the Global South, it can be safely assumed that, at the very least, per capita meat demand in high-income countries needs to decline if we are to reach environmental goals.

Because a decline in meat consumption is clearly needed, meat taxes also need to be evaluated on the basis of how much they actually reduce the demand for meat. The evidence on demand responses to higher meat prices has been mixed thus far, with own-price elasticities ranging from –0.78 to –1.68 (Gallet 2010), suggesting that consumers are only moderately responsive to higher meat prices. Notably, demand reactions are strongest for beef and lamb, which are also associated with the highest social costs. The environmental effectiveness of a meat tax further depends on the environmental impacts of those goods that consumers choose instead when faced with higher meat prices, including other types of meat (Bonnet, Bouamra-Mechemache, and Corre 2018). From an optimal regulation perspective, substitution toward goods that are associated with comparatively large environmental damages (e.g., fish, dairy) is problematic only if such goods are themselves unregulated or suboptimally regulated. Evidence of such detrimental substitution effects would thus strengthen the case for extending regulation to environmentally harmful substitutes for meat.

A clear disadvantage of consumption taxes on meat is that they ignore potential efficiency gains at the source. Where such efficiency gains are significant (e.g., animal welfare, prevention of antimicrobial resistance) or highly localized (e.g., deforestation hot spots), complementary policies, including direct regulation, will be needed. Moreover, a second-best meat consumption tax does not resolve the trade-offs between different regulatory objectives. For example, while cultured meat innovations may help consumers substitute away from products that are environmentally harmful, they may not alleviate the disease burden that is associated with red and processed meat. Likewise, while some free-range forms of livestock rearing will benefit animal welfare, they may exacerbate other environmental damages (e.g., land use–related damages). This suggests the importance of complementing consumption taxes with direct regulation of producers to ensure certain minimum standards for rearing conditions and environmentally sustainable farming practices.

Getting Meat Producers on Board

Attempts to increase taxes on animal-based products will likely face strong resistance from stakeholders, especially livestock farmers. Thus, mitigating the negative effects of policy interventions on meat producers will improve the chances that interventions with net societal benefits will also be politically feasible.

Overall, the impacts of meat taxes across livestock farmers are likely to be context specific, depending, for example, on the (local) possibilities for switching to other farming activities as well as the preexisting regulatory environment (e.g., the structure of agricultural subsidies). One political economy advantage of consumption taxes on meat is that they apply to both domestic and imported products. Thus, such taxes can alleviate competitiveness concerns and prevent disproportionate impacts on domestic producers relative to foreign producers (Gollier and Reguant 2021). Moreover, compared with regulation through standards, meat taxes create additional revenue that can be used to compensate producers and incentivize the switch to more sustainable crops and farming practices. For example, the revenue from environmental taxes on livestock farming could be targeted to livestock farmers for agricultural activities that enhance ecosystem services (e.g., carbon sequestration from peatland restoration). For example, in a study of carbon taxes on food products in Sweden, Gren, Höglind, and Jansson (2021) find that such payments can significantly enhance the environmental effectiveness of the tax reform while also increasing the net income of farmers. Although rewarding farmers more generously for the ecosystem services provided by their farmlands would appear to be an effective and equitable option, it is also important to adjust existing regulations, especially agricultural subsidies.

Finally, consumer elasticities for animal-based products reflect personal and cultural preferences. It is possible that as the environmental and health externalities of meat consumption and production become more apparent, consumer choices will evolve in a way that results in individuals eating less but more expensive meat, providing a potential pathway for the meat sector in the future.

Will the Public Ever Support a Meat Tax?

Given the important role of meat in both culinary traditions and social identity, meat consumption is a politically charged issue in many parts of the world. It is thus likely that the

public will resort to ideologically motivated reasoning when faced with proposals to tax meat (Kahan 2012). With this in mind, we examine both the potential effectiveness and political feasibility of meat taxation.

Social identities and the adaptability of culinary traditions to reduced-meat diets may influence the effectiveness of meat taxes in changing dietary patterns. First, meat taxes will likely interact with people's intrinsic motivation to reduce meat consumption (Lanz et al. 2018). For example, research on meat purchasing behavior where consumers have incorrect beliefs about animal welfare suggests that meat taxes may crowd in (i.e., encourage) more ethical purchases (Hestermann, Le Yaouanq, and Treich 2020). Second, habit formation plays an important role in meat demand (Holt and Goodwin 1997). In fact, while culturally ingrained habits concerning meat eating may initially hamper the incentive effect of meat taxation, a societal shift in food habits toward more vegetarian and plant-based diets could enhance the effect of price interventions (Konc, Savin, and van den Bergh 2021). Finally, when dietary preferences are endogenous, meat taxes could be complemented with broader changes in the retail and food consumption environments experienced by consumers to make meat-reduced diets more attractive (Hawkes et al. 2015; Mattauch et al. 2022).

Concerning the political feasibility of meat taxation, the social and cultural factors discussed above may explain the strong public opposition to meat taxes in some countries. In France, for example, meat taxes are one of the most unpopular environmental protection measures, with only 17 percent of French survey respondents supporting them (Douenne and Fabre 2020). It is unclear whether this opposition is due to citizens' lack of awareness of the mitigation potential of changing meat consumption, skepticism of the "Pigouvian" effectiveness of meat taxes (that increases in prices indeed reduce demand), or a sense that their "way of life" and cultural identity are under attack. This latter argument, which would imply variation in the reaction to meat proposals across countries, has not been systematically studied.[22]

Nevertheless, meat taxation policies can be designed in ways that increase public support. Indeed, research on carbon pricing suggests that policy framing (such as calling it a "levy" rather than a "tax") and use of revenues are key factors in ensuring public support (Klenert et al. 2018). Fesenfeld et al. (2020) show that policy packaging can enhance support for meat taxation in China, Germany, and the United States, with moderately high meat taxes being popular when combined with animal welfare standards, discounts on vegetarian meals, and information campaigns. Fesenfeld et al. (2020) also find that more ambitious meat taxes can be made more appealing to consumers by simultaneously lowering agricultural subsidies to meat farmers, introducing more stringent farming standards, and using tax revenue to support low-income households. This suggests that to garner public support for meat taxes, the economic arguments that we have discussed here will need to be modified for the specific country context.

Conclusions and Directions for Future Research

This article has assessed the potential of meat taxes to counter the many sometimes interacting externalities and economic distortions associated with livestock farming and meat consumption.

[22]See S5 in the appendix for information about the large variations in meat consumption across countries at similar income levels.

Our review of the empirical evidence on the social costs of meat suggests that meat is significantly underpriced when the costs of the relevant environmental and health externalities are considered. Overall, we find that (ignoring interaction effects) an environmental tax that covers GHG emissions and nutrient pollution would increase the current retail price of meat in high-income countries by roughly 20–60 percent, depending on meat type. However, this is a conservative lower-bound estimate because it does not consider the costs of livestock-related biodiversity loss or the private health costs of high meat consumption due to diet-related illness.

While we have argued that consumption taxes on meat can help mitigate some of the negative environmental and public health impacts of meat consumption, we have also emphasized the importance of designing such taxes with any remaining uncorrected distortions in environmental and food markets in mind. We have also highlighted the trade-offs between simplicity, efficiency, and feasibility when designing policies to regulate the livestock sector. Although consumption taxes on meat ignore production-side abatement options, they have advantages over other forms of regulation because they are relatively straightforward to implement and can ease the competitiveness concerns of domestic producers. Moreover, standard economic approaches to optimal tax design may need to be modified to alleviate the burden on meat consumers and producers and ensure public support.

Finally, our review of the literature suggests that further environmental economics research is needed to improve both our understanding of the economic damages from animal agriculture and the design of optimal meat taxes. In particular, there is a need for research on the economic valuation of biodiversity loss that is driven by livestock farming. Moreover, we need to better understand the extent to which indirect land-use effects increase the direct environmental damages from livestock. There is also a need for second-best modeling of taxes and other instruments, which could be used to identify the interactions between environmental regulation, the diet-related adverse health effects of meat consumption, and distributional effects. Although an emerging literature in welfare economics has explored the role of animal welfare in economic valuation, further public economics research is needed to identify how different normative positions on animal welfare and diet-related health affect the design of meat taxes. Another important area for future research is to use causal inference methods (i.e., econometric approaches) to evaluate fiscal policies for meat once they are in place. Finally, technologies for alternative proteins and meat substitutes will soon start to have a significant impact on the demand for meat; while there are estimates of how their expected costs will decrease, further research is needed to identify the most effective regulations for fostering these alternatives to meat.

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