Pay as you eat dairy, eggs and meat

External cost estimates and policy options to internalise them in Germany

CE Delft

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Content

Summary

Livestock farming and the consumption of animal products is important in Germany. Yet, the production and consumption of animal products is associated with a wide range of environmental problems: global warming, eutrophication of soils and waters that lower biodiversity, emissions of ammonium that are formed into secondary aerosols harming human health and extensive land use that comes at the expense of nature and biodiversity.

These effects are known as 'external costs'. In this study, we estimate the external environmental costs of animal products: beef (both from beef, veal and dairy cows), pork, chicken, eggs and cheese, including hard cheese. These are shown in Table 1 with regard to the various environmental impact categories. Impacts associated with ammonia emissions (PM, marine and terrestrial eutrophication, and terrestrial acidification) are dominant in the total external costs, followed by climate change, toxicity categories and agricultural land occupation. These latter three impacts are strongly related to feed production for all animal systems, in addition to methane emissions in cattle systems.

Our analysis shows that external costs are substantial, ranging between the € 0.29 for a litre of milk to € 10.16 per kg of beef. These external costs are primarily caused by emissions of greenhouse gasses plus ammonia from manure handling and its application as a fertiliser (plus artificial fertiliser) for growing crops for feed. Ammonia has many health related impacts and it puts the environment under stress (eutrophication and terrestrial acidification). It is therefore no surprise that cattle systems, which have high ammonia emissions, also have the highest external costs.

Table 1 - External cost estimates for meat, eggs, milk and cheese in Germany (€/kg, conventional farming)

Impact category	Unit	Beef - Beef cattle (incl. veal)	Beef - Dairy cattle	Pork	Chicken	Eggs	Milk	Cheese (Gouda)
Particulate matter formation	€/kg	3.65	0.54	0.57	0.35	0.27	0.08	0.66
Climate change	€/kg	2.21	0.56	0.41	0.38	0.21	0.08	0.68
Marine eutrophication	€/kg	1.60	0.22	0.13	0.07	0.06	0.03	0.26
Terrestrial acidification + terrestrial eutrophication	€/kg	1.18	0.17	0.17	0.08	0.06	0.03	0.20
Agricultural land occupation	€/kg	0.66	0.12	0.14	0.08	0.06	0.02	0.14
Terrestrial ecotoxicity	€/kg	0.68	0.21	0.41	0.36	0.29	0.03	0.26
Human toxicity	€/kg	0.12	0.02	0.03	0.02	0.01	0.00	0.03
Photochemical oxidant formation	€/kg	0.04	0.01	0.01	0.01	0.00	0.00	0.01
Freshwater eutrophication	€/kg	0.01	0.01	0.01	0.00	0.00	0.00	0.01
Ionising radiation	€/kg	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Freshwater ecotoxicity	€/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marine ecotoxicity	€/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ozone depletion	€/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urban land occupation	€/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**€/kg**	**10.16**	**1.87**	**1.89**	**1.36**	**0.97**	**0.29**	**2.25**

These external costs comprise the unpaid bill of consuming animal products. The fact that meat prices and dairy prices currently do not cover substantial external costs in Germany leads to prices that are low enough to incentivise overconsumption. In total we estimate the external costs of environmental pollution of livestock (for the whole of Germany) as high as € 22 bln per year. In this study we have only focused on the environmental impact as part of the unpaid bills. Most likely the 'real' unpaid bills are higher for several reasons. The sector receives considerable subsidies that are not being paid by the consumer of animal products. Besides, the sector is the cause of numerous outbreaks of animal diseases (which are paid for by taxpayers in many countries). Moreover, the animal production sector has a severe impact on human health, zoonoses and resistance to antibiotics and it has poor standards for animal welfare that can only persist by hiding them from the general public. However, we have not derived external cost estimates for those non-environmental categories in this study.

External costs of consumption of animal products can be most effectively combatted by making the consumers pay for those costs. Only then will consumers take the environmental impact into account when deciding to consume animal products or one of the plant-based alternatives and the sector can be steered towards cleaner production methods and alternatives for animal products. Pricing instruments are therefore most effective when addressing the issue of unpaid bills in the animal products sector.

In this study, we have investigated an excise levy for German consumption of meat and the removal of the lower VAT tariff on animal products. Both schemes are feasible from a legal perspective and can be implemented, although the levy needs more scrutiny with regard to practical design questions such as where the taxation point should be and whether imports/exports should be addressed in the scheme. The easiest measure to implement would be the removal of the lower VAT tariff for animal products in Germany. The lower VAT tariff for meat can be labelled as an 'environmental harmful subsidy'. Phasing out environmentally harmful subsidies is a commitment of the EU Roadmap for Resource Efficiency. Various EU Member States, such as Bulgaria, Denmark and the three Baltic States, have not granted lower VAT tariffs for meat or dairy. Germany could follow their lead. This would reduce meat consumption by about 5.6% for beef, 3.4 % for chicken and around 4.5% for cheese, eggs, milk and pork. Government revenues would be around € 5.7 billion. In Germany, a high VAT rate for meat, dairy and eggs would reduce GHG-emissions by 3.4 Mton CO_2-eq.M/year.

Although easy to implement, a higher VAT rate for animal products would have the drawback that it does not fully cover the external costs of meat consumption. For that, additional measures could be considered, either on top of the VAT increase or as a substitute. In this study, we have investigated the option of a levy equivalent to the external costs of meat. The levy would raise € 16 billion of government revenues per year and reduce annual GHG emissions by about 17 Mt over the value chain. The most straightforward way of introducing a levy would be to implement an excise levy on meat sold to consumers by retail companies (supermarkets) and food services (catering, restaurants, etc.), irrespective of whether this meat is produced in Germany or in another country.

Higher VAT rates and/or a levy would mean that costs of consumers still wanting to consume meat will increase which would reduce their purchasing power. Consumers could be compensated by recycling government revenues from a VAT increase on meat products, to distribute the revenues evenly over the population through a 0% VAT on vegetables and fruit, bread, grains, organic food and meat/dairy alternatives or a (free food) voucher, a healthy food gift card, which could be spent in supermarkets on fruit or vegetables, for

example. If one voucher per inhabitant is issued, this would amount to € 68 per person from the VAT increase, or € 193 per person from the government revenues in a system with a levy. Alternatively, consumers could be (partly) compensated by a VAT relief (to 0%) for fruit and vegetables and the remaining money could be spend on a VAT relief to 0% on more food products such as meat/dairy alternatives, organic food products, bread and grain products. In this way, the price of a supermarket shopping trolley of an average German consumer will not increase or might even decrease.

1 Introduction

1.1 Background

Livestock farming is an important branch of the German economy. Certain forms such as grazing, contribute to the preservation of the cultural landscape. Farm animals of old and rare breeds are also part of agrobiodiversity (UBA, 2021). Germany has around 12.9 million head of cattle in total, including 4.2 million dairy cows and 0.7 million suckler cows. Germany has the largest dairy cattle herd and the second largest cattle population in the European Union, contributing about 25 percent to agricultural output in Germany.[1]
Farm animals are also considered to be an essential part of the circular economy, especially for organic farming.

At the same time, livestock farming and consumption of animal products in Germany has a significant negative impact on environment and the climate. The number of livestock is so high that national climate targets for agriculture are at risk (UBA, 2021). The current domestic consumption and export-produced quantities of meat and milk in Germany can only be produced with the help of imported feed which require substantial amounts of land. In addition, ammonia emissions have negative consequences for human health and ecosystems. Far-reaching changes are therefore needed to transform agriculture and especially to make animal husbandry ecologically compatible (UBA, 2021).

The role of prices is crucial here. From a social and environmental point of view, animal products are priced too low because a large part of the environmental damages are not included in the price. This concerns, for example, the costs of climate change and environmental pollution due to the emission of various substances. These types of costs are well-known as 'external costs'. As such costs are not included in the price of animal products, consumers overconsume such products and under consume products with lower environmental impacts.

Inclusion of the social costs into the product prices of meat is therefore an important prerequisite in bringing animal production within the borders defined by our ecosystem. This research identifies what action needs to be taken.

1.2 Project aim and approach

The aim of the project is to provide policy proposals that can be used to pass on the external costs via the price of meat, dairy and eggs. The overall project covers the following three parts:

- Calculate external costs for meat, dairy and eggs for Germany on average. It indicates what price increase would be needed to cover the external costs.
- Identify policy options to increase the price of meat, dairy and eggs and estimate the expected impact of two selected financial policy options on the environment.
- Describe what can be done with the government revenues to create political and social support, including some quantitative examples.

[1] Information obtained from: http://www.germanlivestock.de/german-cattle.html

A Supervisory Committee provided us with useful insights and feedback on the analyses. The members were:

- Pierre Marie Aubert and Nathalie Bolduc (L'Institut du développement durable et des relations internationales, IDDRI, France).
- Reinhild Benning (Deutsche Umwelthilfe e.V., DUH, Germany).
- Élodie Vieille Blanchard, Pauline Abela and Anna Lab (Association végétarienne de France, AVF, France).
- Joey Cramer (ProVeg, Netherlands).
- Siska Pottie (European Alliance for Plant-based Foods, EAPF, Belgium).
- Jan Paul van Soest (Food Transition Coalition, TCV, and De Gemeynt, Netherlands).
- Jeroom Remmers (TAPP Coalition, Netherlands).

In this research we have produced a main report with extensive technical details on the calculation of the external costs for animal products in the EU27, Germany and France. The present report contains an analysis of the results for Germany only. The other reports are available on the website of TAPP and CE Delft.

1.3 Scope and research boundaries

In this research we have estimated the external costs associated with the following animal products: meat (chicken, pork and beef), dairy (standardised milk and cheese) and eggs. The environmental impact of those products have been estimated over the value chain of production and cover cradle to gate: the whole production chain up to the moment that the meat is sold to retail.

Table 2 - Environmental impact covered

Environmental impact categories	
Climate change	Freshwater eutrophication
Ozone depletion	Marine eutrophication
Human toxicity	Land use - urban
Photochemical oxidant formation	Land use - agricultural
Particulate matter formation	Terrestrial ecotoxicity
Ionising radiation	Freshwater ecotoxicity
Acidification	Marine ecotoxicity

In addition, the following research boundaries have been defined:

- External cost estimates will cover the environmental impact of the current production characteristics in livestock farming and product industries only. In addition, the environmental impact animal production is being associated with a wide range of societal problems: animal diseases (zoonoses), health damage caused by the consumption of meat, issues with animal welfare. desiccation, depletion of the soil or antibiotic resistance. We also did not calculate possible positive 'external' effects of meat, dairy and eggs (e.g. nice landscape for recreation purposes). Although relevant, these impacts are outside of the scope of the present study and could be investigated in future research.
- The analysis will consider the situation 'today' of conventional (non-organic) farming and information to date on policy initiatives and existing policy framework in the countries/regions under consideration.

- Environmental impacts are valued for their damage on human health, natural capital (ecosystems) and man-made capital (buildings/materials) using a valuation scheme used in EU policy appraisals. The valuation is based on average prices for the EU27 (see Annex C.1 one in the main report).
- When figures are expressed in €/kg meat, we mean kilograms of meat sold (and thus excluding carcases unless they are part of the sold products), unless explicitly stated that it is in 'carcass weight'.

1.4 Methodological introduction

This paragraph gives a brief methodological introduction on the methods employed in this research. Full details of our methods are given in the main report of this series.

The environmental impact of animal products for the fourteen impact categories in Table 2 have been determined using life cycle assessment (LCA). The analysis covers direct emissions at the farm level and indirect emissions in the chain, related to animal feed, energy mix and transport in the production chain. Transport to retail and transport to consumer are out of scope of the present analysis. The LCA models are based on LCA models of animal products in the Agri-footprint LCA database (v5.0), with specific adjustments for Germany provided by Ecologic. Annex 1.6. of the main report shows in detail the methods employed in this research.

The external costs have be calculated by the following formula:

$$EC_j = \sum_{i=1}^{14} I_{i,j} * EP_i$$

Where *EC*=external costs of one kg of animal product *j*, $I_{i,j}$ is the environmental impact on environmental theme *I* associated with one kg of animal products *j* and EP_i are the environmental prices for environmental theme *i*. There are in total fourteen environmental themes (see Table 2). The external costs of one kg of animal product j is then the sum of the impact multiplied by the environmental price for all themes.

Environmental prices for each theme have been taken from the Handbook of Environmental Prices (EU28 version) by CE Delft (2018). The values from this Handbook have frequently been used to determine the external costs from LCA-analysis (see e.g. (Costantini, 2020), in cost-benefit analysis (see e.g. (UNEP, 2020)) or by companies in reporting about their Environmental Profit and Losses (see e.g. (Philips, 2018). The environmental prices also form the basis of the European Handbook of valuing external costs of Transport for DG Move (CE Delft et al., 2019) and are frequently used in European policy analysis.

Although Germany has their own valuation framework from the Methodenkonvention (UBA, 2020), we do not know if environmental impacts occur within the German borders or in other countries. That is one of the reasons why we have used European prices. The other reason is that the Methodenkonvention does not provide LCA-midpoint values and only a subset of environmental impacts has been monetised.

1.5 Reading guide

This report contains analysis and results for Germany. In Chapter 2 we present our results of the analysis of the external costs in Germany from consumption of animal products. We express the external costs both in per kg consumed product and as total for Germany and compare our estimates with others in the literature. Then in Chapter 3 we analyse pricing instruments that can be used to internalise these external costs and discuss their design, the impact and revenues that they generate and how these revenues can be recycled back to consumers. Chapter 4 concludes.

1.6 Relation to the main report

In the main report on the EU27 (CE Delft, 2022a) all assumptions and data sources of the method have been listed in Annex A. The reader is referred to this main report for further explanation on how the environmental impacts have been modelled and what environmental prices have been taken to value the environmental impacts.

2 Estimation of external costs of animal products in Germany

2.1 Introduction

External costs of animal products are costs that matter to society but are not paid by those that produce and consume animal products. In economic terms this implies that total welfare is lower. In more popular terms, the external costs can be described as the unpaid bill from producing and consuming animal products.

In this chapter, we present our calculation of the external costs from animal products for food in Germany. In Section 2.2 we discuss the scope. Section 2.3 reveals the results for Germany and in Section 2.4 we discuss implications and compare our results with elsewhere found in the literature. Readers interested in the methodologies that have been used in deriving those figures are referred to the main report that contains detailed account of the methodologies applied to derive these external cost estimates.

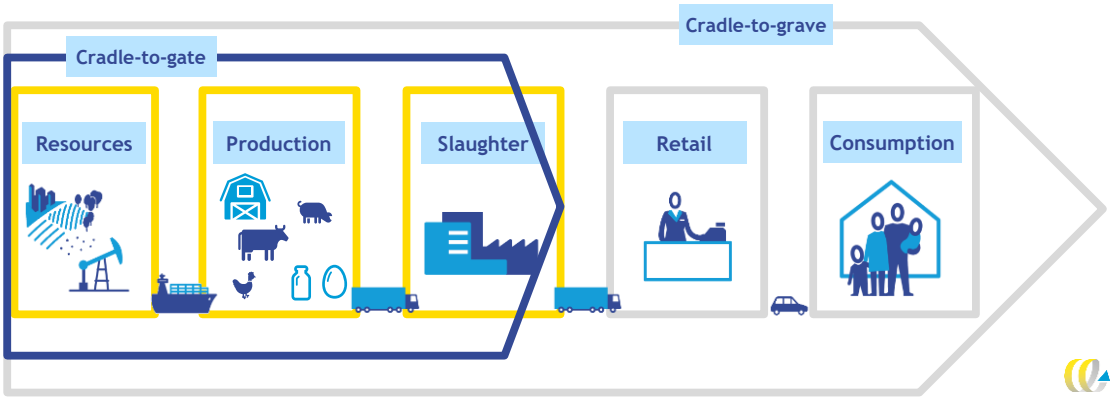
2.2 Scope

Our analysis contain all the external costs that occur in the cradle to gate route in the value chain. Figure 2 gives a graphic representation. The analysis covers direct emissions at the farm level and indirect emissions in the chain, related to animal feed, energy mix and transport in the production chain. These aspects have an influence on the impacts of (the production of) the products on nature and the environment. Transport to retail and transport to consumer are out of scope (grey rectangles in Figure 1). These cover a very small share of total environmental impacts only.[2]

The environmental impact estimates have been based on current average emissions for farming systems in Germany. This means that we implicitly take into account the fact that livestock farming production systems differ per region. More details about the way we have modelled environmental impacts can be found in Annex A of the main report.

[2] E.g. (Poore & Nemecek, 2018) report that the sum of emissions from packaging, transport, and retail contributes to 1 to 9% of total emissions. However, they do not provide details on each individual chain so their results cannot be used in the present analysis. Transport required to take feed to livestock is included in our analysis.

Figure 1 - LCA scope

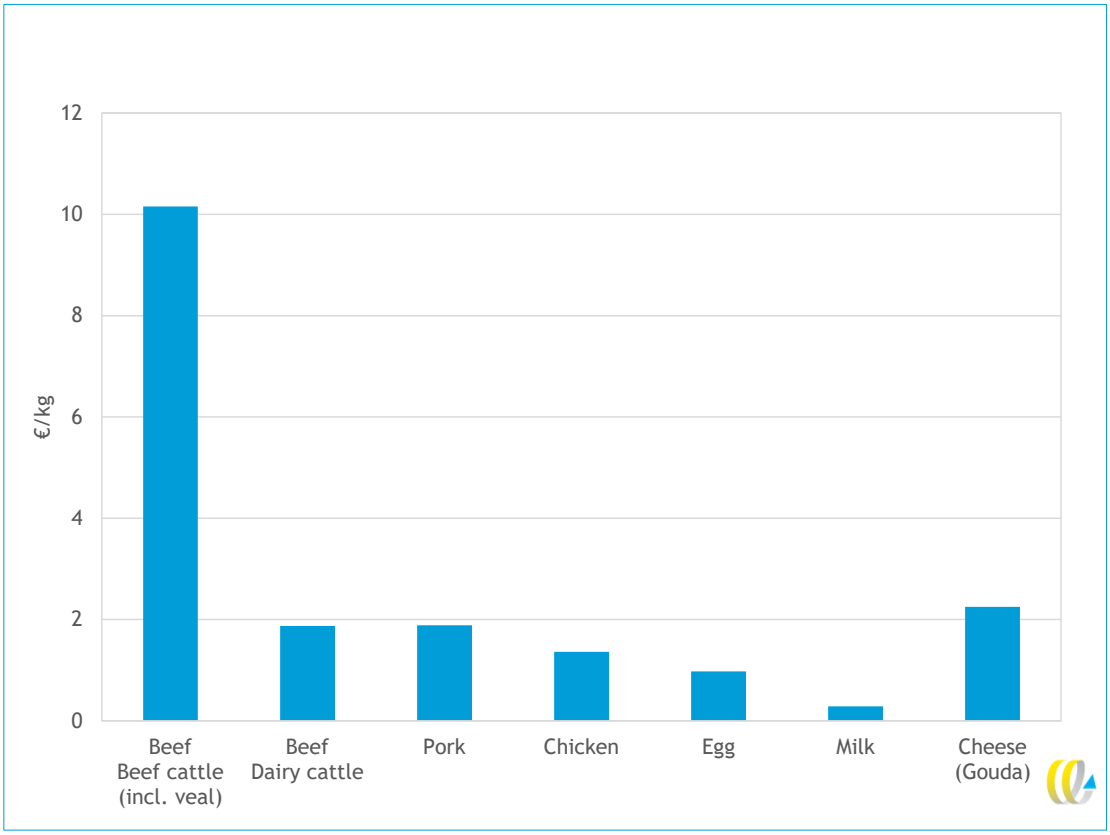


The LCA models applied have been made specific for Germany by focussing on emissions of NH_3, CH_4, N_2O, CO_2 and NO_3. Initial analysis revealed that over 75% of external costs in the various animal products are caused by these emissions. Inventory data on farm level emissions of NH_3, CH_4, N_2O was acquired from the EU National Inventory and Informative Inventory reports (European Environment Agency, 2021a). When emission data could not be divided between animal product group, the most conservative data from France, Germany or the original Agri footprint process card were used as proxy, in order to avoid underestimation of emissions. Other (indirect) emissions were made specific for Germany by adapting inputs of the production system. As such, manure application rates and composition of feed was made country-specific where possible. For soy-based feed, direct land use was adjusted for the share of certified 'deforestation-free soy'. Finally, ammonia emissions from crop residues in grass and maize cultivation were recalculated according to the recent NEMA method (RIVM, 2021), which resulted in different (lower) emission values of feed throughout cattle production models than what is normally included in the Agri footprint database. In Annex A of the main report, all details of the method have been given.

2.3 External costs estimates

Valuing the quantified environmental impacts from LCA with the environmental prices provides an estimate of the external cost for the various animal products. These are shown in Figure 4. This figure shows that beef from beef cattle (including veal) production causes the highest external costs (10.16 €/kg), followed by cheese (2.25 €/kg), pork (1.89 €/kg), beef (from dairy cattle, 1.87 €/kg), chicken meat (1.36 €/kg), eggs (0.97 €/kg) and milk (0.29 €/kg).

Figure 2 - Total external costs of conventional meat, eggs, milk and cheese in Germany (€/kg)



The comparatively high external costs of beef from beef cattle result for the largest part from high particulate matter (PM) emissions, followed by climate change impact, marine eutrophication, and terrestrial eutrophication and terrestrial acidification (Table 3). These are in turn mostly caused by ammonia from manure handling and application and artificial fertilizer application for feed. Ammonia has many effects on human health (PM) and the environment (eutrophication and terrestrial acidification) and it is therefore no surprise that cattle systems, which have high ammonia emissions, have high external costs.[3]

Next to PM, beef from beef cattle has a relatively high climate impact due to methane emissions during its lifetime, and impacts related to feed production (beef cattle needs a lot of feed to produce 1 kg of meat, much more so than pigs or chickens).

Beef from dairy cattle has a significantly lower impact than beef from beef cattle because most of the impact related to the lifetime of a dairy cow is allocated to the milk, and not the meat. Milk has a relatively low impact as a cow produces a lot of milk over a lifetime, which causes less impact per kg product. The external costs of 1 kg (Gouda) cheese are relatively high; almost as high as beef from dairy cattle. This is due to the fact that around 8 kg of milk is needed to produce 1 kg of cheese.

[3] Please recall that environmental prices are averages for an average emission at an average location. However, particulate matter emissions in agriculture are usually in rural areas, so with a much lower population density. This is partly blown into the city (see e.g. (IIASA, 2014), but not entirely. This means that the cost figures include an upper limit for the harmfulness of particulate matter emissions.

The external costs of pork and chicken meat are lower than beef meat and cheese. Chickens have the best feed conversion efficiency of all animals in this study and therefore the external costs associated with chicken products are relatively low. Pigs have a more diverse diet with less soy (which has high associated external costs) and therefore the impact per kg of pig feed are lower than a kg of chicken feed. The net external costs of chicken meat however are still lower due to more efficient feed conversion.

Table 3 shows the external costs of the animal products, attributed to the different environmental impacts and as totals. The importance of the environmental impact categories in the total external costs are quite similar for most animal products. Impact categories associated with ammonia emissions (PM, marine and terrestrial eutrophication, and terrestrial acidification) are dominant in the total external costs, followed by climate change, toxicity categories and agricultural land occupation. These latter three impacts are strongly related to feed production for all animal systems (in addition to methane emissions in cattle systems).

Table 3 - External cost estimates for meat, eggs, milk and cheese in Germany (€/kg)

Impact category	Unit	Beef Beef cattle (incl. veal)	Beef Dairy cattle	Pork	Chicken	Eggs	Milk	Cheese (Gouda)
Particulate matter formation	€/kg	3.65	0.54	0.57	0.35	0.27	0.08	0.66
Climate change	€/kg	2.21	0.56	0.41	0.38	0.21	0.08	0.68
Marine eutrophication	€/kg	1.60	0.22	0.13	0.07	0.06	0.03	0.26
Terrestrial acidification + terrestrial eutrophication	€/kg	1.18	0.17	0.17	0.08	0.06	0.03	0.20
Agricultural land occupation	€/kg	0.66	0.12	0.14	0.08	0.06	0.02	0.14
Terrestrial ecotoxicity	€/kg	0.68	0.21	0.41	0.36	0.29	0.03	0.26
Human toxicity	€/kg	0.12	0.02	0.03	0.02	0.01	0.00	0.03
Photochemical oxidant formation	€/kg	0.04	0.01	0.01	0.01	0.00	0.00	0.01
Freshwater eutrophication	€/kg	0.01	0.01	0.01	0.00	0.00	0.00	0.01
Ionising radiation	€/kg	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Freshwater ecotoxicity	€/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marine ecotoxicity	€/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ozone depletion	€/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urban land occupation	€/kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**€/kg**	**10.16**	**1.87**	**1.89**	**1.36**	**0.97**	**0.29**	**2.25**

2.4 Interpretation

Environmental impacts from livestock farming are currently not taken into account by both the producers and consumers of animal products. They sell and buy products at prices that do not include these costs and environmental impacts therefore barely play a role in decisions about investments or purchases. The fact that meat and dairy prices are currently not covering substantial external costs in Germany leads to prices that are low enough to incentivise overconsumption. In total we estimate the external costs (for the whole of Germany) as high as € 22 bln.

Table 4 - Total external costs from meat and dairy product consumption in Germany, 2020

	Beef*	Pork	Chicken	Milk	Eggs	Cheese	Total
Consumption (mln tonnes)	0.94	2.72	1.25	4.32	1.24	2.11	12.58
External costs (bln €)	8.3	5.1	1.7	1.2	1.2	4.8	22.3

* Assuming 84% beef from beef cattle and 16% beef from dairy cattle.

These external costs form the unpaid bill of consuming animal products in Germany. However, this should be regarded as a lower estimate for various reasons. First, not all meat products have been included in our analysis: meat from sheep and goats have not been included. Moreover, in this study we have only focussed on the environmental impacts as part of the unpaid bills. Most likely the 'true' unpaid bills are higher because the sector receives considerable subsidies (that are not being paid by the consumer of animal products), is the cause of numerous outbreaks of animal diseases (for which in many countries taxpayers pay), has a severe impact on human health through zoonoses and resistance to antibiotics and has poor standards for animal welfare that can only persist by muffling them away from the general public. However, we have not derived external cost estimates for those categories in this research.

There are, to our knowledge, also no external cost estimates in the literature that include all of these categories. There are a number of studies that have undertaken a similar type of analysis, and our results are in the range of what can be expected. Compared to an earlier study by CE Delft on this subject (CE Delft, 2018a); (CE Delft, 2020), the external costs for the products are different. This both due to the different approach followed for the LCA models (see Annex A in the main report) and due to different external costs for impact categories. The previous study used environmental prices for direct emissions in the Netherlands and the present study uses such prices at the level of the EU27+UK. As the Netherlands is much more densely populated than the European average, air pollutants cause much higher damage to human health.

When comparing the results with the previous analysis, we observe that especially the external costs of pork are much lower. This is mainly because this study uses more recent data from efficient pig production systems, which are more representative of average large-scale pork production. To a lesser extent the differences are explained by differences in external costs.

When compared to other literature on this subject external costs are more or less in line. (Funke, et al., 2022) calculated, on the basis of data from (Poore & Nemecek, 2018), the external costs for beef between US$ 5.75–US$ 9.17 per kilogram (the higher range for beef from meat cows and the lower range for beef from dairy cows), US$ 1.94 per kilogram for pork, and US$ 1.50 per kilogram for poultry. These estimates are slightly lower than our results. However, they state that they did not include a valuation for biodiversity loss or the health effects from livestock-related air pollution. The latter impact is in our estimate the largest category of external costs through the impact in the particulate matter formation. So all in all the costs estimated by us and (Funke, et al., 2022) are probably in line.

Other estimates exist. These results are interesting to mention, even though not directly comparable to the results of our study, given differences in methodologies, selections of environmental aspects and data sources. (Pieper, et al., 2020) report external costs for greenhouse gasses and land use changes only. The environmental price of greenhouse gasses emissions is 180 €/ton CO_2-eq. versus 80 €/ton used in our study. Other environmental

impact categories are not included. The analysis results in external costs for beef in Germany of 6,65 €/kg, for poultry 2,85 €/kg, for pork 1,72 €/kg and for milk 0,24 €/kg (all conventional, non-organic). (Michalke, et al., 2020) calculated German external costs for minced meat (9,67 €/kg), gouda cheese (4,38 €/kg) and milk (0,89 €/kg) (all conventional), based on external costs for energy, greenhouse gas emissions, nitrogen and land use. This is also more or less comparable with results we found in our study.

Older research on valuation of external costs of meat exist (see e.g. (IVM, 2010)), but these studies used quite some older data on impacts and valuations that the results are hardly comparable.

3 Policy instruments

3.1 Pricing instruments

Many economists are in favour of pricing mechanisms to stimulate behavioural change of both consumers and producers. Pricing instruments have important advantages over other forms of climate and environmental policies, such as setting standards or granting subsidies[4]. Pricing systems, especially when adopted on a larger scale, have the advantage that they are:

- Effective: increased prices for non-sustainable goods ensure that producers and consumers consider the effects on the climate/environment in their decisions so that the composition of the consumption package or the production structure is directed towards a more sustainable, low-carbon economy.
- Efficient: higher cost prices drive innovations and investments in energy-efficient and low-emission technologies, making the transition to a more sustainable economy cheaper.
- Fair: higher prices create a sense of justice in society whereby the polluter pays for environmental damage that is caused and no longer passes it on to others or future generations.

While the advantages of pricing instruments have long been recognised in (environmental) economics see e.g. (Baumol, 1988); (OECD, 1989), it has taken some decades before pricing instruments for environmental pollution have become widespread. Nowadays, pricing environmental pollution has become more common for politicians and consumers.
For example, 68 carbon pricing schemes have been counted at the moment in the World (World Bank, 2022), among which the European Emissions Trading Scheme (EU ETS) and national carbon taxes in the Netherlands, France, Spain, etc.

In general, pricing instruments can be classified into two categories:

1. (Behavioural) taxation based on a fixed charge.
   Unlike other taxes, the main aim of a behavioural tax is not to generate government revenues, but to reduce consumption of particular products or lessen their environmental impact by making it more expensive. The amount of environmental impact is uncertain; it depends on the behavioural response to raising (cost) prices. The taxation rate can be based on a politically agreed decision, like a VAT increase, or based on the actual external costs per kg of product.
2. Trading systems in which the maximum environmental impact is fixed by an annual ceiling (the cap) and permits are traded on the market. This means that the permit price is not fixed. A well-known example is the current European Emissions Trading System (ETS) system for greenhouse gas emissions. The CO_2(-eq.)-price that must be paid for emissions depends on the supply and demand on the market for emission rights.

[4] One of them being the 'free rider'-problem, granting subsidies to those parties that would have taken the measures anyway, making the policy instrument quite expensive and inefficient.

Application of the polluter pays principle in animal products is still very limited, despite the academic world has considered application of taxes much more effective than, e.g. labels or giving information (Katare, 2020). Recently, there been initiatives to introduce economic pricing instruments in both categories with respect to food products. New Zealand is likely to be the first country to bring agriculture under an ETS system and Germany is currently considering a consumer tax on animal products. In other countries, including the UK, US and Finland, Sweden and Denmark, 'meat taxes' are currently being considered. Also at the EU level it is starting to attract political attention (FAIRR collective, 2020). Some countries, such as the Netherlands, consider a meat tax part of a broader policy package to encourage consumers to buy affordable, and more healthy and sustainable food. A tax on meat could then, for example, be combined with a tax increase on soft drinks and recycling revenues by lowering (or scrapping) the value added tax on fruit and vegetables and a sugar tax. This is by no means a hypothetical situation. In 2020, at least 40 countries have some form of sugar tax in place, including France, the UK and Mexico (FAIRR collective, 2020). A number of European countries have an (extra) reduced VAT rate on fruit and vegetables, including Ireland (0%), Spain and Italy (4%) (European Public Health Alliance, 2019). Such initiatives increases the price difference between animal based food products and vegetables and fruit.

The details of policy design are crucial to ensure public and political support for price instruments. They related to the treatment of imports and export (level playing field for companies and avoiding carbon leakage) and the earmarking of the government revenues (subsidise 'healthy food', support lower income groups and/or help companies to invest in sustainability). Limiting undesirable (income) effects and conducting careful communication is crucial. Otherwise, social resistance might cause absence of political will to actually implement 'unpopular' financial policy measures.

3.2 Policy context

Historically, there are vested interests and lobbying at work to avoid application of the polluter pay principle in German livestock farming, as in many other countries and sectors. Instead, meat products have been indirectly subsided by the Common Agriculture Policy (CAP) and reduced VAT prices because they are considered as basic food. It is unpopular to making meat more expensive, and getting the state involved - even more so than for car fuels (Ecologic, 2022).

Hence, since 2017 there has been discussion about the low VAT rate (7%) that applies in Germany not only to plant products, but also to animal products. This was considered an 'environmentally harmful subsidy' (FAIRR collective, 2020). The VAT system in Germany can be debated for its definition(s). For example, the definition of basic food items is very arbitrary. E.g. oat milk is not considered as a basic food item but cow milk is (Ecologic, 2022).

In 2019, a commission of core stakeholders chaired by former Federal Minister of Agriculture Jochen Borchert was implemented by the Ministry of Food and Agriculture (BMEL) to work out policy instruments for the future reform of livestock farming in Germany with the focus on animal welfare. The body includes decision-makers and experts from politics, science, associations, businesses and NGOs brought together for the first time. The advice of this commission (Kompetenznetzwerk Nutztierhaltung, 2020) was largely appreciated by the different stakeholders, the German parliament and the Government. Both a feasibility study (Karpenstein, 2021) and impact assessment (Deblitz, 2021) were carried out, commissioned by the government afterwards. Three pricing options were elaborated on in more detail:

- excise levy on animal products (including meat € 0.47/kg, cheese/butter € 0.18/kg and Milk/eggs € 0.02/kg);
- higher VAT rate on animal products (from the reduced VAT rate of 7% to the standard rate of 19%);
- supplement levy on animal welfare.

Unfortunately, the discussion of policy instruments has never resulted into a decision-making process, probably also due to the COVID-19 pandemic and German parliamentary elections in 2021. The new coalition agreement does supports political action[5], but the window of opportunity is quite narrow at the moment.
The integration of livestock into the EU ETS was not part of any political discussion in Germany.[6] In fact, emission trading in agriculture never made it past the stage of academic ideas in Germany. On the one hand this is remarkable, as the German and EU livestock sectors are important sources of (greenhouse gas) emissions. Integrating it in EU ETS (as a separate system for livestock in the EU) would increase the coverage of the system. Besides, Germany acknowledges the benefits of emissions trading and recently set up a national CO_2 budget system for (road) transport and the built environment (see Textbox 1). New Zealand plans to integrate livestock in their national ETS scheme by 2025 (see Section 1.5). Alternatively, a national trading system might cap the total *number* of animals at the level of slaughterhouses and meat importers (instead of emissions).

Textbox 1 - German national ETS for road transport and built environment

As of 2021, the German national CO_2 budget is effective. It caps the emissions of per year, based on the EU Effort Sharing Scheme. Air and ship traffic are not covered by this national ETS. In principle, the rights will be auctioned and mutual trade will take place. In the first phase (2021-2025) a fixed price has been set for which rights are sold; it increases from € 25/tonne CO_2 in 2021 to € 55/tonne in 2025. An upstream system has been chosen in which energy suppliers must submit rights for (CO_2-causing) fuels that they have supplied to consumers and businesses. The costs for these rights are then passed on to end users[7]. To compensate for these price increases, the commuting allowance will be increased, a mobility premium has been introduced and reducing the surcharge paid via the energy bill to stimulate renewable energy (EEG surcharge) is considered **Ongeldige bron opgegeven.**.

5 It states that the new federal government wants to support farmers in the conversion to more animal-friendly livestock farming. To this end, a financial system supported by market participants is to be developed. The income from this system will be earmarked to offset the running costs of farms and to support investments. Also, the new federal government wants to reduce environmentally and climate damaging subsidies and expenditures (Koalitionsvertrag SPD, BÜNDNIS 90/Die Grünen, FDP 2021-2025).

6 As decisions are made at the European level, individual member states do play a role here through their national representatives. Livestock farming could be included in the ETS regime, as is currently the plan for the Built Environment and Transport sector.

7 Delivery to companies that fall under the EU ETS is exempt, and where there is overlap with the EU ETS, refunds will be made.

On the other hand, there might be (more) limitations in the agricultural sector to implement such a trading scheme at the national or European level. Some of them are:

- Levelling the playing field through an ETS would be a challenge, given the subsidies that are provided to the agricultural sector under the Common Agricultural Policy (CAP). It is crucial to correct the existing incentive structures, by shifting potentially environmentally harmful agricultural support towards targeted environmental payments. Such CAP reforms might be more effective than adding another mechanism. However, those reforms might be difficult to realise and can only be proposed every seven years (next option for change is 2028).
- Emission markets have long lead times until they become effective. The history of the ETS learns that it started already in 2005 and it lasted until 2018 until it finally started to work.
- A national ETS or ETS extension requires solving some serious issues with respect to accurate Monitoring, Reporting, Verification (MRV) and rigid enforcement. The fear of the carbon pricing/ETS community is that inclusion of agricultural activities and food consumption into the EU system might water down the high standards achieved thus far (Ecologic, 2022). For taxation, MRV systems must also be in place, but the required level of detail depends on the exact design (see Section 3.2) and it is easier to include a development path to a differentiated system over time.

In sum, it is most worthwhile to consider the implementation of an excise levy and VAT increase for Germany. In the next paragraphs they will be described in more detail.

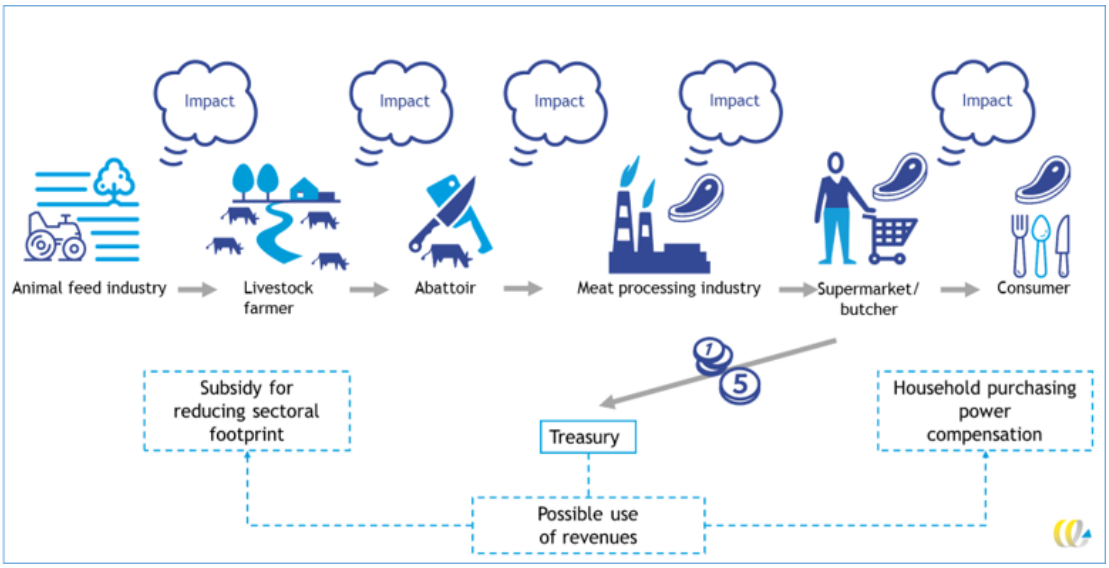
3.3 Excise levy

3.3.1 Types of levy

We distinguish here between a generic levy and a value chain levy. A generic levy will only differentiate the type of meat. In this sense, the levy very much works like an excise duty, similar to duties on alcohol or cigarettes. The tax is levied on the amount of meat, dairy and eggs (tax base) that is sold to end consumers. The advantage of this levy is that it is relatively straightforward and that similar levies have successfully been implemented in many countries worldwide. The disadvantage of this levy is that it stimulates less consumption of meat but does not necessarily stimulates cleaner production techniques in the value chain.

Another type of levy would be to base the levy on the external costs added in each production step. This is the basis of the External Cost Charge in which the added external costs in each production step are being taxed (CE Delft, 2020). The ECC aims to include the environmental impact during the entire supply chain up to the end consumer in the product prices. In each production step, ECC taxes the added external costs. Figure 3 provides an example for the meat production chain. Such approach would create the optimal price incentives for both producers and consumers to avoid/reduce the external effects. Hence, meat from livestock farmers who cause few external costs, a lower taxation rate is paid per kg of meat than when it comes from livestock farmers who cause high external costs.

Figure 3 - Ideal picture of excise levy based on ECC



This requires an extensive monitoring and reporting system with regard to the external costs that are being added in each production step ((CE Delft, 2018b). If only GHG is being monitored, it works like a Carbon (eq.) Added Tax (CAT). While such schemes do have great benefits in combining incentives for farmers with incentives for consumers, they are complex in monitoring and reporting regulations and so far they have not been implemented in any country in the world.

A simplified scheme in the end will boil down in an external cost charge for end consumers, which is similar to the excise duty above based on external costs. We will use this in this study: the height of the levy is then similar to the external costs and the unit of charge is the mass of meat, dairy and eggs sold (all converted into kg). This requires producers of products containing meat, dairy and/or eggs to register the amount of processed animal products. Either they pay taxes based on this information or they have to inform the next actors in the supply chain, so that the levy is paid at the final consumer level.

Table 5 shows the excises levies for the various animal products when they reflect the external costs estimates (see Chapter 1.6), with the highest costs for beef and lowest for milk.[8]

[8] Since circumstances might change, both within the sector (sustainability of farming) of outside (environmental prices reflecting the welfare loss due to production and consumption of animal products), the levy should be reviewed periodically

Table 5 - Excise levy on meat, dairy and eggs, based on ECC (€/unit of product, 2021)

	Levy (€/kg product)
Beef (beef cattle incl. veal)	10.16
Beef (dairy cattle)	1.87
Average beef	8.83*
Pork	1.89
Chicken	1.36
Milk	0.29
Eggs	0.97
Cheese	2.25

* Average based on 16 and 84% share of meat from dairy and beef cattle respectively (see Annex A.1.3 in main report).

3.3.2 Taxpayers and taxation point

An excise-like levy means that a given amount must be paid to the national government per kg of meat, dairy and eggs. The levy is added to the retail price. The taxation point can be placed at three levels.

The first option is to introduce the levy when the product is sold to the consumer (retail and food services like restaurants, catering companies). The seller then pays a rate based on the amount and type of product sold (beef, pork, chicken, dairy, eggs). This means that sellers have to report the amount of meat, dairy and eggs sold to end consumers and the meat, dairy, egg processing industries. The advantage of this approach is that a significant amount of sales is covered by the excise levy. For example, about 85% of the sales of meat (products) is to consumers (CE Delft, 2018a). The levy thus provides the incentive for consumers to switch to products with less meat, dairy and egg ingredients or animal products with lower environmental impact as they pay the levy.

If the levy would also apply to composite products containing animal products, food manufacturers may change their product compositions (less animal ingredients) to limit price increases. In addition, no import or export corrections are necessary as the tax is levied on products sold to consumers. Imports are then treated the same as domestically produced goods. A disadvantage is that the cost increase associated with environmental pressure is only 'visible' when sold to consumers. The price impact must be passed on in the chain, so the incentive for the livestock farmers to shift their production towards less animal products is only indirect. In case markets work efficiently, this should not be a problem. However, existing distortions in the market on e.g. land ownerships, subsidies through the CAP and monopsony in retail may distort the price signal to producers.

With a levy at the point of consumption, farmers have no incentive to use cleaner production methods as these will not be 'rewarded' with a lower levy. This could partially be circumvented by introducing labels or categories that would apply for a lower levy. Then, tariff differentiation is possible instead of an average tariff for each product category. Information requirements are high as reliable registration of environmental impacts in the product chain is needed and the risk of failing Monitoring, Reporting and Verification (MRV) is high.

A second option is to choose a taxation point more downstream in the chain. In that case, slaughterhouses, dairy and egg producers and meat, dairy and egg importers (mainly processing industries) are liable to pay the levy. Although it can be assumed that the tax

will be (partly) passed through into consumer prices, it limits the number of actors directly under the scheme. Since the tax is levied on all products manufactured or imported into the country, exports would also be covered by the scheme. To maintain an international level playing field, a refund must be made for exports which makes administrative costs higher.

A third option is to place the taxation point at the livestock farmer level. As they are directly confronted with the taxation bill, it would give farmers the most direct incentive to use (new) techniques or methods that reduce external effects in the production of the good, or to switch on the production of other goods that have fewer externalities. This particularly holds when the tariff is differentiated with regard to production methods. There is also a more direct incentive for the buyer of the meat to purchase meat from livestock farmers whose production causes less environmental impacts.

Under this latter option there is a potential risk of relocation of polluting activities abroad (leakage) due to a competitive disadvantage since only meat from German livestock farmers is taxed. To correct for this, cross-border adjustments for both imports and exports need to be made which may be difficult to monitor, inflict on existing trading agreements, run the risk of retaliation and be perceived as unfair towards developing countries. Therefore this point of taxation seems to be less promising.

3.3.3 Environmental impact

Based on the levies in Table 5, we roughly estimate the price increase, the expected reduction in German consumption of animal products, associated reduction in environmental impact and related welfare gains (based on environmental prices).

Price increase

Table 6 shows the price details of the animal products in Germany, based on (BMEL, 2021) and the impact of a levy on the average product price. In this analysis, the levy accounts for 100% of the external cost estimate. In practice a growth patch might be chosen, due to political reasons or to allow parties to get used to the system, starting for example with 10% of external costs, increasing over the years to 50% and ultimately 100%. Subsequently, the estimates presented in this paragraph show the *maximum* impact levy. Per product category, we chose an average product with an average price.

Table 6 - Excise levy on meat, dairy and eggs, internalising the external costs (€/unit of product, conventional farming, 2021)

	Beef	Pork	Chicken	Milk	Eggs	Cheese
Name of product	Rinder-braten	Schweine-kotelett	Brathähnchen, gefroren	Frischmilch, ab 3,5 % Fett	Eier Boden Kl M 6-12 Pck.	Gouda jung, Bed.
Current retail price (€/kg excl. VAT, 2020)*	€ 9.67	€ 6.42	€ 2.54	€ 0.81	€ 2.22	€ 7.19
Levy (€ per kg)	€ 8.83**	€ 1.89	€ 1.36	€ 0.29	€ 0.97	€ 2.25
Price increase (%)	91%	29%	54%	35%	44%	31%

* Average prices from all obs. shops of the food retail (BMEL, 2021).

** Weighted average of beef from beef cattle incl. veal (84%) and beef from dairy cattle (16%).

Consumption decrease

Due to the introduction of the excise levy, consumer will pay more for their animal-based food products as before. Based on average consumption levels per head before the introduction of the levy (see Table 7), an inhabitant would spend almost € 100 a year more on beef, about € 60 more on both pork as well as cheese and around € 15-20 more on chicken, on milk and on eggs. In practice, the increase in expenses will be lower because consumers will buy less of these products.

The impact on the quantities of animal products consumed and related expenditure on these products are determined on the basis of price elasticities of demand. They measure the change in the quantity purchased of a product in relation to a change in its price. The values in Table 7 are based on German-oriented literature (Deblitz, 2021) and they also fall well within the ranges for mid-term price elasticities based on meta-analysis of international literature (see (CE Delft, 2018a)). In accordance with several studies the price elasticity of beef highest, followed by pork and dairy products. Lowest impact is supposed to be on chicken meat(see Annex C.2 of main report for details).

Lower consumption of the taxed products, creates additional demand for alternative products. This will be partly a desired effect when people switch to plant-based products. Hence, it is also possible that they shift to other animal based products as become relatively cheaper as they face lower tax tariffs[9]. This would be an undesired effect when demand increases for products that are worse for animal welfare, as the aim is fostering the transition towards the consumption and production of less and 'better' animal products.[10] An undesired shift would occur when a lower rate on chicken compared to beef causes a consumption shift towards chicken. However, earlier research of (CE Delft, 2018b) and (CE Delft, 2020) indicates that a ECC-based levy would cause a net reduction in chicken meat consumption, even when the tax level would be lower than beef. (Ecologic, 2022) also expects only a small substitution effect, if any. Substitution effects (consuming, for instance, pork instead of beef when prices for beef rise faster than prices for pork) are taken into acount through a conservative approach to price elasticities of demand.[11]

A second impact path leads through reformulation of product compositions by food manufacturers in order to keep the price increase as low as possible. The less animal products are included (e.g. on a pizza or in a meal), the lower the price increase due to the excise-like levy. This impact is not quantitively included in the analysis.

In Table 7 and Figure 4 reveal the decrease in consumption due to the introduction of an excise levy covering the full external costs estimated in Chapter 1.6. They show that consumption of beef can be reduced by 46% if the beef sector is fully paying for their external costs. Reductions between 12-18% will be achieved among the other animal products.

9 Tariffs are highest for beef, followed by pork and chicken, in accordance with the environmental impact.

10 Beef might be a worse product for environmental reasons, but better for animal welfare. Animal welfare is not included in the analysis, see Section 1.3.

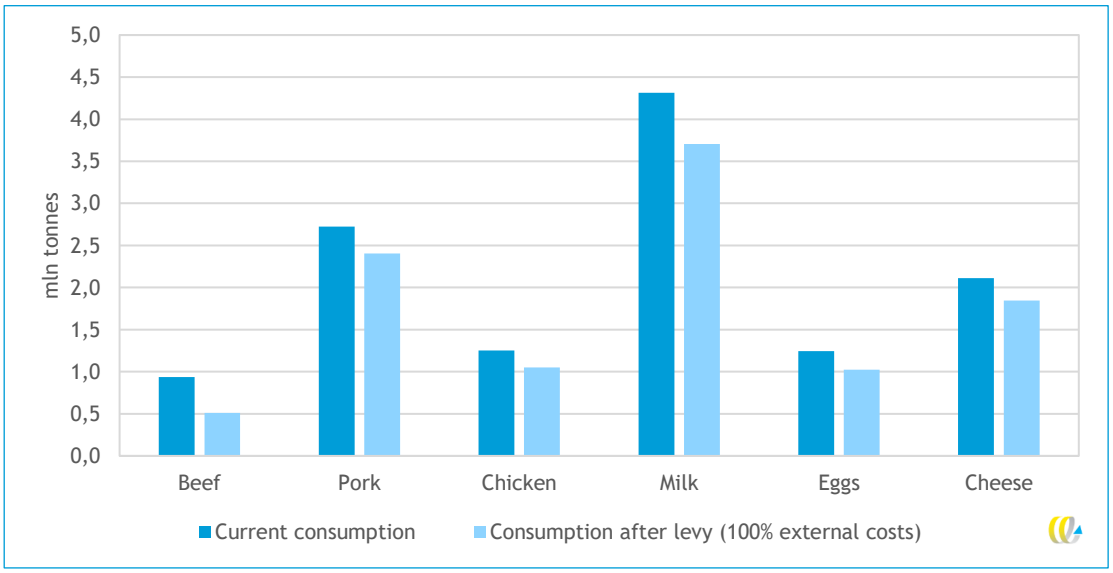
11 Cross price elasticities are expected to be low. By deliberately estimating one's own price elasticities lower, the substitution effects can be met without having to use cross elasticities (see (CE Delft, 2018a).

Table 7 - Annual consumption figures of animal products before and after introducing a levy

	Beef	Pork	Chicken	Milk	Eggs	Cheese
Current situation						
Consumption level (million tonnes, carcass weight, 2020)	1.21	3.73	1.29	4.32	1.24	2.11
Consumption level (million tonnes, product weight, 2020)	0.94	2.72	1.25	4.32	1.24	2.11
Consumption per head (product kg/year, 2020)	11.3	32.8	15.1	51.9	15.0	25.4
After introduction of levy						
Price increase	91%	29%	54%	35%	44%	31%
Price elasticities	-0.5	-0.4	-0.3	-0.4	-0.4	-0.4
Change in consumption (%)	-46%	-12%	-16%	-14%	-18%	-13%
New consumption level (million tonnes, product weight)	0.5	2.4	1.1	3.7	1.0	1.8

Note: Current consumption figures based on (BMEL, 2021).

Figure 4 - Consumption levels before and after introduction of a levy (million tonnes/year, 2020)



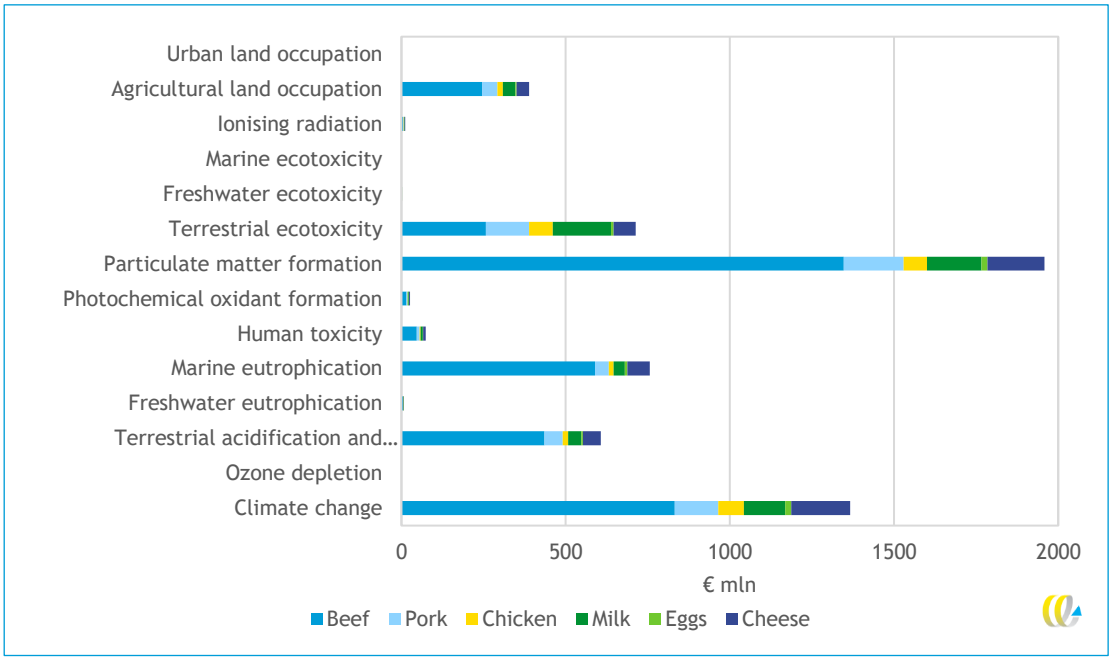
Environmental impact and welfare gains

As a result of the consumption decrease, pressure on the environmental lowers as well. For example, the reduction in CO_2-eq. emissions would be about 17.4 Mton (indicative estimate). The total welfare gain due to less environmental effects would be about € 5,900 million per year of which around € 1,300 million would be related to climate change benefits and € 4.600 million to other environmental impacts (excluding so-called deadweight losses due to the foregone consumption of animal products). Most welfare gains arise due to the reduction in PM formation and land occupation, as Figure 5 shows.[12]

[12] Impact not corrected for increased CO_2 emissions, etc. due to greater consumption of meat substitutes. In CE Delft (2018) it is estimated that this will offset 15-25% of the welfare gains.

Per inhabitant, the annual total welfare gain is about € 71 on average, which involves € 16 on climate-related issues and € 55 related to other environmental themes. These are substantive impacts, but also related to significant price increases.

Figure 5 - Total welfare gains due to reduced environmental impact after introducing a levy (million €/year)



3.3.4 Administrative and regulatory issues

Administration and implementation costs can be expected to be high as the system has to be newly developed. When the levy is paid when the product is sold to the consumer, retailers need to report the amount of meat, dairy and eggs sold to end consumers and/or the processing industry. The regulatory government organization needs to process and check these declarations. If slaughterhouses and importers pay the tax, they need to report their sales (excluding exports) and import of meat, dairy, eggs and products that contain them. This increases the implementation costs, as governments also have to check imports and export corrections. If taxes are implemented at the farm level, farmers may have to register their emissions. As insight in the supply chain is needed, it would be best to develop/use existing MRV system that comply with EU regulations. Especially when the levy is differentiated, it is crucial that registration is reliable. This will be a challenge, not to be solved in the shorter run.

An excise levy seems to be legally feasible in Germany, even though the legislator does not have an unlimited 'right to invent taxes'. The permissible types of tax are defined in Art. 106 of the constitutional law. The legislator must orientate himself according to the permissible types, when creating new taxes (Karpenstein, 2021).
According to this study the financing of the transformation of livestock farming through the revenue of a volume-based levy on animal products in the form of an excise-like levy seems possible. Neither constitutional law nor EU law fundamentally preclude the introduction of such a tax. The tax would have to be modelled on the existing excise-like levy in Germany.

The federal government would also be entitled to the revenue from the tax. Earmarking (see Section 3.5) would also be possible in accordance with the budgetary and constitutional requirements. However, such earmarking entails the risk of a conflict with the EU discriminatory law (Karpenstein, 2021).

3.3.5 Government revenues and political support

Government revenues of the levy amount to € 16 billion, based on a levy that fully covers the external cost estimates. The increase in revenues is the total consumption of meat and dairy multiplied by the levy, minus the lost VAT revenues due to a decreased consumption. These revenues can be recycled to compensate low and middle-income households for purchasing power losses and/or subsidise the livestock sector to further reduce its environmental footprint (see Section 3.5).

Sometimes, governments decide to use a scheme with stepwise or gradual increasing tariffs, to give consumers and producers some time to adjust. Such growth path can start with a levy of 20% of the external costs, ultimately reaching 100%. Especially when the external costs are high, as with beef, such approach might be needed to gain sufficient support for implementation.

3.4 VAT increase

3.4.1 Taxpayers, taxation point and tariff

A Value Added Tax (VAT) means that a percentage is added to the retail. It is paid when products are sold to the customer. In Germany, there are two VAT rates, 7 and 19%. Generally, the basic food needs have the reduced VAT rates of 7%. This includes animal-based products such as fresh meat, dairy and eggs. They can be made subject to the highest VAT rate of 19%. This was part of the discussion by the commission of stakeholders and was evaluated by a feasibility study (Karpenstein, 2021).

3.4.2 Environmental impact

Based on a VAT increase of 12%, we roughly estimate the expected reduction in German consumption of those products, associated reduction in environmental impact and related welfare gains (based on environmental prices).

Price increase

Table 8 reveals the current annual consumption of animal based products and the impact of a VAT rate increase (from 7 to 19%) on the average product price. Per product category, we chose an average product with an average retail price. These prices increase with 11.2% due to the VAT increase. Comparing the price increase due to higher VAT with the external costs reveals that the VAT increase covers only part of the total external costs: ranging from only 13 for beef (average) to 41% for pork.

Table 8 - Price details VAT increase

Category	Beef	Pork	Chicken	Milk	Eggs	Cheese
Name of product	Rinder-braten	Schweine-kotelett	Brathähnchen, gefroren	Frischmilch, ab 3,5 % Fett	Eier Boden Kl M 6-12 Pck.	Gouda jung, Bed.
Current retail price (€/kg incl. 7% VAT, 2020)*	€ 10.35	€ 6.87	€ 2.72	€ 0.87	€ 2.37	€ 7.69
Retail price high VAT (€/kg incl. 19% VAT, 2020)*	€ 11.51	€ 7.64	€ 3.02	€ 0.97	€ 2.64	€ 8.56
Price increase	11.2%	11.2%	11.2%	11.2%	11.2%	11.2%
External costs (conventional farming)	8.83	1.89	1.36	0.29	0.97	2.25
Part of external costs covered by VAT increase	13%	41%	22%	34%	27%	38%

* Average prices from all obs. shops of the food retail (BMEL, 2021).

** Weighted average of beef from beef cattle incl. veal (83%) and beef from dairy cattle (17%).

Consumption decrease

Due to the VAT increase, consumer face higher prices for animal-based food products as before. Based on average consumption levels per head before the VAT increase (see Table 9), an inhabitant would spend about € 15 a year more on beef, about € 20-25 more on both pork as well as cheese and around € 5 more on chicken, on milk and on eggs. In practice, the increase in expenses will be lower because consumers will buy less of these products.

The impact on the quantities of animal products consumed and related expenditure on these products are determined on the basis of price elasticities. The values in Table 9 are based on German-oriented literature (Deblitz, 2021) and they also fall well within the ranges for mid-term price elasticities based on meta-analysis of international literature (see (CE Delft, 2018a). In accordance with several studies, the price elasticity of beef is considered to be highest, followed by pork and dairy products. Lowest impact is supposed to be on chicken (see Annex C.2. in the main report for details).

As discussed in the previous paragraph, higher prices are expected to lower the consumption of the taxed products and create additional demand for alternative products. In Table 9 and Figure 6 reveal the decrease in consumption due to the VAT increase. Consumption will drop with 3 to 6%.

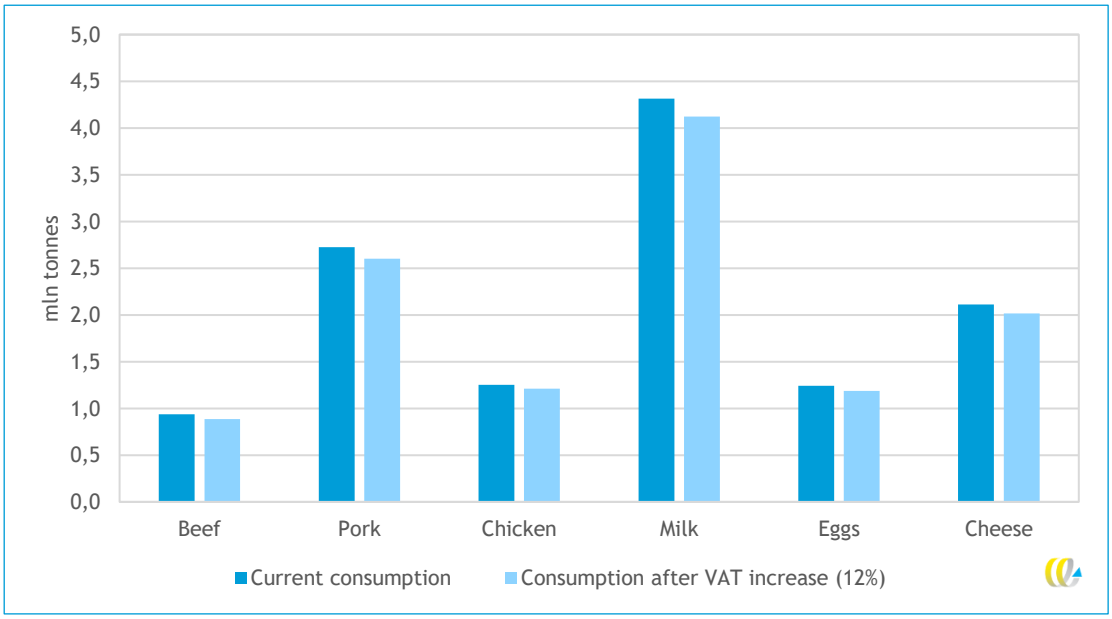
Table 9 - Annual consumption figures of animal products before and after the VAT increase

	Beef	Pork	Chicken	Milk	Eggs	Cheese
Current situation						
Consumption level (million tonnes, carcass weight, 2020)	1.21	3.73	1.29	4.32	1.24	2.11
Consumption level (million tonnes, product weight, 2020)	0.94	2.72	1.25	4.32	1.24	2.11
Consumption per head (product kg/year, 2020)	11.3	32.8	15.1	51.9	15.0	25.4

	Beef	Pork	Chicken	Milk	Eggs	Cheese
After VAT increase						
Price increase	11.2%	11.2%	11.2%	11.2%	11.2%	11.2%
Price elasticities	-0.5	-0.4	-0.3	-0.4	-0.4	-0.4
Change in consumption (%)	-5.6%	-4.5%	-3.4%	-4.5%	-4.5%	-4.5%
Consumption level (million tonnes, product weight)	0.9	2.6	1.2	4.1	1.2	2.0

Note: Current consumption figures based on (BMEL, 2021).

Figure 6 - Consumption levels before and after a 12% VAT increase (million tonnes/year, 2020)



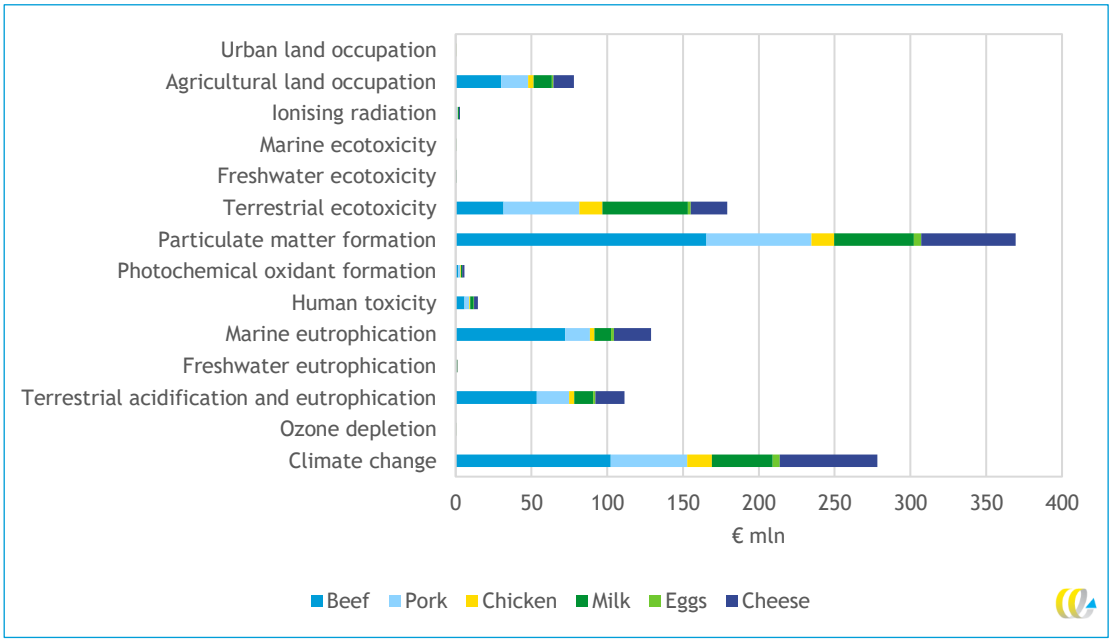
Environmental impact and welfare gains

As a result of the consumption decrease, pressure on the environmental lowers as well. For calculating the environmental gains, the simplifying assumption is made that all German consumption is covered by domestic production.[13] With respect to climate change, a reduction of 3.4 Mton CO_2-eq. emissions would be realised (indicative estimate). The total welfare gain due to less environmental effects would be about € 1,170 million per year of which € 280 million is related to climate change benefits and € 890 million to other environmental impacts. Most welfare gains arise due to the reduction in PM formation and land occupation, as Figure 7 shows.[14] Per inhabitant, the annual total welfare gain is € 14 on average, which involves € 3 on climate-related issues and € 11 related to other environmental themes.

[13] Similar as in (CE Delft, 2018a). Within the context of this study, it was not possible to conduct import/export analysis.

[14] Impact not corrected for increased CO_2 emissions, etc. due to greater consumption of meat substitutes. In CE Delft (2018) it is estimated that this will offset 15-25% of the welfare gains.

Figure 7 - Total welfare gains due to reduced environmental impact due to VAT increase (million €/year)



3.4.3 Administrative and regulatory issues

Administrative and implementation costs are rather low as the measure relies on an already established VAT system. For combined food products including meat, dairy and eggs (e.g. pizza's, bread with a hamburger) a decision has to be made in what kind of VAT tariff the product should have: the reduced or standard VAT rate?

With respect to legal issues, particularly the principle of fiscal neutrality would have to be observed. According to this, it is not permissible to treat 'similar goods or services' which are in competition with each other differently with regards to VAT (Karpenstein, 2021). However, at the moment plant-based products such as oat or soy milk have the highest VAT rate of 19% even if they are in direct competition with dairy products. Therefore, the argument of 'similar goods or services' is more an orientation than a binding standard (Ecologic, 2022).

The VAT revenue would be shared between the federal government and the federal states (Bundesländer). The respective shares are determined by federal law (Federal government: 52.8%, federal states: 45.2%, municipalities: 2%). In principle, there is legislative leeway for the distribution of the additional revenue from an increase in the reduced VAT rate (Karpenstein, 2021).

3.4.4 Government revenues

Governments VAT revenues increase with € 5.7 billion when the standard VAT rate applies to meat, dairy and eggs instead of the current reduced rate. As mentioned, these revenues can be used to in several ways (see Section 3.5 on earmarking).

3.5 Recycling of revenues through earmarking

The excise levy and VAT increase yield government revenues of € 16 and € 5.7 billion respectively. These revenues can be used to stimulate the consumption of 'healthy food', compensate households for higher prices and/or stimulate sustainable livestock farming through subsidies. The need to compensate undesirable side effects of meat taxes, etc. is also urged by (UBA, 2021).

On the one hand, the revenues can be used to compensate for a loss of purchasing power for certain groups. This may concern the sector itself, as it is confronted with a cost increase that can lead to a reduction of the profit margin (if the costs are not passed on one-to-one) and a loss of turnover (if demand decreases when costs are passed on). Famers could be compensated by providing subsidies from the revenues for, e.g., investments in products and methods of production that allow for lower environmental impacts. Such measures have not been investigated further in this research, as a compensating mechanism should carefully consider the amount of pass through of the costs to end consumers, and such lays outside the scope of the present research.

If all costs are passed through to end consumers, or the pricing instruments directly target end consumers, they can be compensated for their loss in purchasing power because of the higher prices. This is especially problematic for low income households as a larger share of their incomes is spend on food products.

There are several ways to compensate consumers:

1. Through a VAT relief for fruit, vegetables and other products (e.g. bread, cereals, organic food, meat/dairy alternatives). In 2019, the Romanian government has decided to promote the consumption of healthy and traditional foodstuffs by cutting their VAT rate from 9 to 5% (Euractiv, 2019). In April 2022, Greenpeace Germany (Wiegmann, 2022)presented a report on VAT increase on meat, dairy and eggs in different EU countries, and proposed at the same time to reduce VAT rates to 0% on vegetables, fruit, cereals and bread, allowing consumers a net benefit of about € 50 per capita per year (based on average diets). The advantage of a VAT relief is that it does not discriminate towards household income. Every household will benefit equally from this.
2. Through a reduction in other taxes, e.g. income taxes. Taxing environmental impact and recycling money back to lower labour taxes has often been considered giving double dividends: lower pollution and lower unemployment (see e.g. (Topal, 2017)). Reduction of labour taxes could thus be a good idea, especially in countries that have a relatively high unvoluntary unemployment. On the other hand, the reduction in labour taxes will only benefit those who have a (paid) job while pensioners and unemployed people will pay for higher taxes but not reap any benefits. Therefore, this measure has distributional consequences which would have to be addressed through other policy measures. Distributional consequences will also appear if other taxes are being lowered such as profit or energy taxes.
3. Through providing a free voucher to citizens to spend on specific food product categories (e.g. vegetables and fruits). France is proposing such food vouchers for low income groups in 2023, to compensate for food inflation.

In this research we will investigate options (1) and (3) which are believed to be the most favorable options for low income households and also discuss options to use the money to introduce more sustainability measures in the sector.

3.5.1 VAT relief for vegetables and fruit

The higher VAT tax revenues or revenues from a levy could be used for a tax relief for fruit and vegetables. In Germany, the VAT on fruit and vegetables is 7%. Household expenditure on fruit and vegetables is around € 62 per month (DESTATIS, 2022). Given the number households of 40.8 million, yearly VAT revenues on fruit and vegetables are just short of € 2 billion. The revenues on the levy on meat or VAT increase for meat are € 16 billion and € 5.7 billion respectively. This indicates that the VAT on fruit and vegetables could be reduced to zero, and more measures should be taken to fully recirculate the levy/VAT increase to consumers. This could, for example, be done in various ways:

- by also providing a VAT relief for other basic necessities such as bread, and sustainable food products like organic food products[15] and meat/dairy alternatives;
- by using the remaining revenues to hand out vouchers (see Section 3.5.2);
- by using the revenues for taking stimulating measures in agriculture for sustainability (see Section 3.6.3).

The VAT relief will have no additional administrative burdens compared to the present system.

3.5.2 Providing food vouchers

Alternatively, the revenues could be used to issue (free) food vouchers (healthy food gift cards) that can be used by consumers. A voucher system has recently been introduced in many countries (e.g. UK) to support struggling households with inflation and help them getting the basic necessities in home. In other countries, such as Belgium and France, a meal voucher system already exists since the late 1960s (EC, 2020). The higher revenues from a levy or VAT increase could be used to set up such a voucher system in Germany. We would propose here to earmark the vouchers only for healthy and sustainable food products, such as vegetables, fruit and organic food.

In the simplest form every citizen would get a voucher. If a single voucher per inhabitant would be issued, this voucher would amount to € 68 per person from the VAT increase, or € 193 per person from the government revenues in a system with a levy.
The voucher system would imply additional administrative efforts. Administrative costs will highly depend on the type of system that will be set up and will also depend on the number of people that can participate. An evaluation of the Italian scheme of a payment card for free purchases for poor people showed that the administrative costs can be expected to be around € 20 per card (EC, 2020). Other sources estimate that administration costs for food related vouchers can be between the 3 and 37% (United Nations, 2007).

Administrative costs can be substantially lower if no voucher for specific purposes is given, but rather a per capita lumpsum money refund that can be freely spend on anything the people want. The lower administrative costs can be achieved because it can connect to existing schemes (e.g. labour taxes, social security support, child benefits). On the downside, the money could also be spent on environmentally unfriendly products, such as airline tickets or meat.

[15] In Romania, a differentiation for certified organic and traditional food products exists. These products have a lower VAT rate compared to conventional food products (5% instead of 9%).

3.5.3 Stimulating sustainability measures in agriculture

Finally, the proceeds can be used to further stimulate the taking of sustainability measures (influencing behaviour). Various target groups are possible for this. When the proceeds are used to stimulate further sustainability in the agriculture sector, the sector is supported to reduce the harmful effects to which the sustainability contribution applies. However, the potential of technical measures is limited. In particular, the currently available technical measures are not sufficient to solve two problems: the large amount of land required in Germany and abroad for the cultivation of feed, and the amount of greenhouse gases produced by livestock farming. Even if production were optimised through technical measures and an improved spatial distribution, the climate targets of agriculture would probably not be achieved and the global load limits would be exceeded (UBA, 2021). So a payment scheme for livestock farmers reducing livestock numbers, can be considered too (like implemented in the Netherlands and Belgium), or giving subsidies to livestock farmers who improve animal welfare standards by adapting stables (such as the current 'Tierwohl Abgabe' proposal).

In order for the food system in Germany to become more environmentally and climate-friendly, livestock farming and human diet have to be changed significantly: This means using both effective technical and distribution measures that can be implemented at short notice to reduce environmental impacts, and the level of production and consumption of animal foods to decrease.

3.6 Conclusion

Given the characteristics of the excise levy and VAT increase, Table 10 shows the evaluation of the two policy instruments. A VAT approach scores high (+) on administrative, regulatory and legislative issues, mainly due to the fact that the VAT system is already in place in Germany. In principle, the VAT increase measure is also effective in providing financial incentives for more sustainable consumption and production. However, the ultimate impact depends on the VAT rate. The evaluated VAT increase from 5.5 to 20% only covers a relatively small part of the total external costs; ranging from only 13% for beef (average) to 41% for pork. Therefore, its score on effectiveness (meaning generating a significant positive impact), would be somewhat lower than the score of an excise levy that covers 100% of the external costs. However, tariff rates are a political choice instead of characteristics of the policy measures *an sich*. Hence, both policy instruments are given a + score as they both provide financial incentives.

When designing an excise levy, the choice of taxation point and taxpayer has a significant impact on the mechanism. It determines the number of actors that are covered by the scheme (and thus administrative and implementation costs), the effectiveness (which actor faces the main financial incentive) and the need to correct for cross border effects (to avoid relocation of polluting activities abroad).

Table 10 - Scores of policy instruments to increase the price of meat, dairy and eggs

Aspect	Excise levy	Excise levy	(Differentiated) excise levy	VAT increase
Taxation point	Consumer level	Slaughterhouses and importers	Farm level	Consumer level
Effectiveness – positive impact on 'greening' consumption and production	++	+	+/++	+
Low administrative burdens for producers	+	+	-	++
Low implementation costs of governments	+	-/0	-	+/++
Legal feasibility	+	+	+	++

Note: Scores indicate the performance of the policy instrument, so - = bad performance, 0 = modest, += good, ++=very good.

4 Conclusion and recommendations

Animal products are an substantial ingredient of current German diets. Yet, the production and consumption of animal products is associated with a wide range of environmental problems: global warming, eutrophication of soils and waters that lower biodiversity, emissions of ammonium that are formed into secondary aerosols harming human health and extensive land use that comes at the expense of nature and biodiversity.

In this study, we estimated the external environmental costs of animal products: beef (both from beef, veal and dairy cows), pork, chicken, eggs and (hard) cheese. Our analysis shows that external costs are substantial, ranging between € 0.29 for a litre of milk to € 10.16 per kg of beef meat. These external costs are primarily caused by emissions of greenhouse gasses plus ammonia from manure handling and application as fertiliser (plus artificial fertilizer) for growing crops for feed. Ammonia has many health related impacts and puts the environment under stress (eutrophication and terrestrial acidification). It is therefore no surprise that cattle systems, which have high ammonia emissions, also have the highest external costs.

These external costs form the unpaid bill of consuming animal products. In this study we have only focused on the environmental impact as part of the unpaid bills. Most likely the 'real' unpaid bills are higher for several reasons. The sector receives considerable subsidies that are not being paid by the consumer of animal products. Besides, the sector is the cause of numerous outbreaks of animal diseases (for which taxpayers in many countries pay). Moreover, the animal production sector has a severe impact on human health, zoonoses and resistance to antibiotics and it has poor standards for animal welfare that can only persist by hiding them from the general public. However, we have not derived external cost estimates for those non-environmental categories in this research.

External costs of consumption of animal products can be most effectively combatted by making the consumers pay for those costs. Only then will consumers take the environmental impact into account when deciding to consume animal products or one of the plant-based alternatives, and the sector can be steered towards cleaner production methods and alternatives for animal products. Pricing instruments are therefore most effective when addressing the issue of unpaid bills in the animal products sector.

In this study, we have investigated an excise levy for German consumption of meat and the removal of the lower VAT tariff on animal products. Both schemes are feasible from a legal perspective and can be implemented, although the levy needs more scrutiny with regard to practical design questions such as where the taxation point should be and whether imports/exports should be addressed in the scheme. The easiest measure to implement would be removal of the lower VAT tariff for animal products in Germany. The lower VAT tariff for meat can be labelled as an 'environmental harmful subsidy'. Phasing out environmentally harmful subsidies is a commitment of the EU Roadmap for Resource Efficiency. Various EU Member States, such as Bulgaria, Denmark and the three Baltic States, have not granted lower VAT tariffs for meat or dairy. Germany could follow their lead. This would reduce meat consumption by about 5.6% for beef, 3.4 % for chicken and around 4.5% for cheese, eggs, milk and pork. Government revenues would be around € 5.7 billion. In Germany, a high VAT rate for meat, dairy and eggs would reduce GHG-emissions by 3.4 Mton CO_2-eq./year.

Although easy to implement, a higher VAT rate for animal products would have the drawback that it does not fully cover the external costs of meat consumption. For that, additional measures could be considered, either on top of the VAT increase, or as a substitute. In this study, we have investigated the possibilities of a levy equivalent to the external costs of meat. The levy would raise € 16 billion of government revenues per year and reduce annual GHG emissions by about 17 Mt over the value chain. The most straightforward way of introducing a levy would be to implement an excise levy on meat sold to consumers by retail companies (supermarkets) and food services (catering, restaurants, etc.) irrespective of whether this meat is being produced in Germany or in another country.

Higher VAT rates and/or a levy would imply that costs of consumers still wanting to consume meat will increase, which would lower their purchasing power. Consumers can be compensated by recycling government revenues from a VAT increase on meat products, to evenly distribute the revenues over the population through a 0% VAT on vegetables and fruit, bread, grains, organic food and meat/dairy alternatives or a (free food) voucher or a healthy food gift card to be spent in supermarkets on fruit or vegetables, for example. If a single voucher per inhabitant would be issued, this voucher would amount to € 68 per person from the VAT increase, or € 193 per person from the government revenues in a system with a levy. Alternatively, consumers could be (partly) compensated by VAT relief (to 0%) for fruit and vegetables and the remaining money could be spent on VAT relief to 0% for other food products such as meat/dairy alternatives, organic food products, bread and grain products. In this way, the price of a supermarket shopping trolley of an average German consumer will not increase or might even decrease.

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