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Pricing GHG emissions in agriculture: accounting for trade and fairness for effective climate policy

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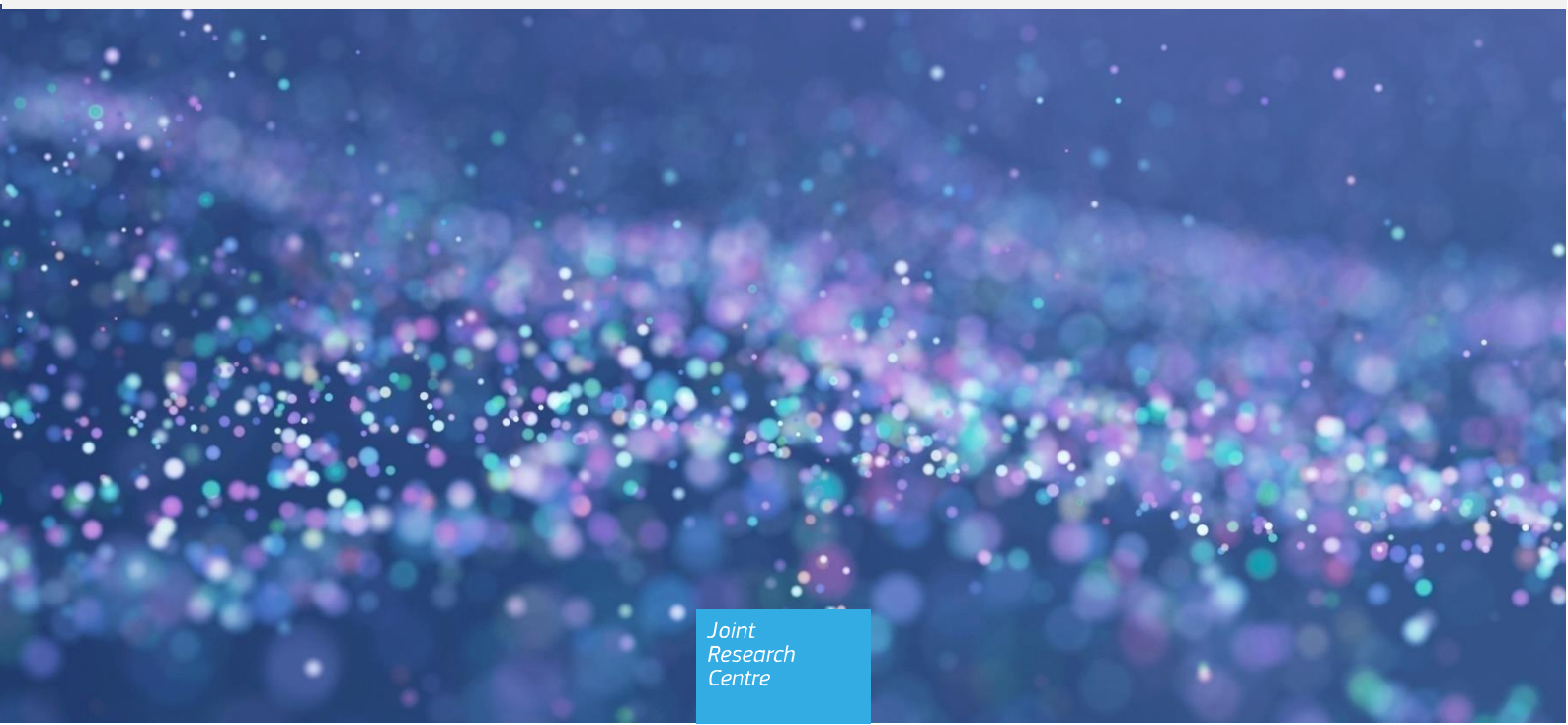

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Executive Summary

The agricultural sector remains largely excluded from greenhouse gas (GHG) pricing, despite being a major source of emissions. To align agriculture with climate goals, this paper examines two pricing mechanisms: supply-side GHG taxes on production and demand-side taxes on consumption. We assess their respective impacts on emissions, EU producers' competitiveness and distributional outcomes.

Analysis and Key Findings:

1. **Environmental Impact and Competitiveness' Concerns**: A supply-side GHG tax in agriculture puts EU farmers at a competitive disadvantage and results in over 40% carbon leakage, as non-EU producers replace European ones. On the other hand, a consumption-based GHG tax levels the playing field, applying equally to EU and foreign products, boosting EU exports of greener products, and generating positive spillover effects.

2. **Case Study on VAT Reform**: We therefore explore a real-world reform based on adjusting Value-Added Taxes (VAT) on food to reflect climate externalities. Our findings indicate that, while this reform can achieve emissions reductions, it is regressive without complementary measures. Households at the lower end of the income distribution are disproportionately affected due to their higher food expenditure share.

3. **Fairness and Compensation Mechanisms**: We propose compensation mechanisms, such as a feebate system or equal-per-capita revenue recycling, to address equity concerns. Both approaches improve welfare for the majority, with a slight burden remaining on the top 20-30% of meat consumers. These measures also help preserve equity and social acceptability of the proposed VAT reforms.

4. **Limitations and Policy Implications**: The VAT-based approach achieves a modest reduction in emissions, as it lacks direct incentives for farmers to innovate and shifts output to export markets. For greater effectiveness, complementary trade measures and enhanced support for farm-level innovation are necessary.

Overall, our analysis suggests that price-based measures, particularly a well-designed VAT reform with appropriate compensation mechanisms, can help align agriculture with climate goals while addressing competitiveness and equity concerns. However, achieving significant emission reductions requires broader policy support beyond mere pricing instruments.

Pricing GHG emissions in agriculture: accounting for trade and fairness for effective climate policy[1]

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Abstract

Although agriculture is an important source of greenhouse gas emissions, the sector remains out of scope for greenhouse gas (GHG) pricing policies. To align the future food system with the transition to net zero emissions, two key questions arise: To what extent can tax policies help achieving this transition in a fair and effective way? And, would it be preferable to levy a GHG tax on the production or the consumption side? We employ an EU agro-economic model to compare production and consumption-side GHG taxes and to quantify their environmental impact. We find that supply-side pricing in agriculture displays leakage rates of over 40% and leaves EU producers in a situation of competitive disadvantage; on the other hand, demand-side measures level the playing field in the Single Market and generate positive leakage as they boost the export of (greener) EU producers. Focussing on four countries – Spain, France, Romania and Poland – we therefore consider a real-world reform based on adjusting Value-Added Taxes to reflect climate change externalities. Using microsimulation techniques and household-level data we show that - while this reform can generate reductions in emissions - is regressive without complementary measures. Feebate and equal-per-capita revenue recycling address equity concerns and produce welfare gains for the majority of the population, while the top 20-30% of meat consumers experiences welfare losses. Overall, findings suggest that price-based measures can help align agriculture with climate goals but trade and equity aspects should be reflected in policy design.

Keywords: climate policies, food system, VAT reform, fairness.

JEL classification: D6, H2, Q1, Q5

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1. Introduction

Food systems were responsible for about one-third of global anthropogenic greenhouse gas emissions (GHG) in 2015 (Crippa et al., 2021). In the EU, current-policy projections suggest that the share of non-CO_2 GHG emissions from agriculture is roughly to double from just under 10% in 2010 to nearly 20% by mid-century (EC, 2021), as current policies imply rapid decarbonization of other sectors. An ambitious and effective climate policy, therefore, cannot overlook the emissions related to food. Yet, price signals for food products in the EU currently do not reflect corresponding environmental damages, and do not help steering consumers towards dietary patterns with low greenhouse gas emissions intensity. At the same time, dietary choices that exacerbate climate change, such as higher consumption of meat, dairy and other processed commodities, are associated with detrimental consequences for public health (Springmann et al., 2016), deforestation, nutrient pollution and ecosystem loss and could indirectly cause premature deaths (Springmann et al., 2023; Himics et al., 2022; Funke et al. 2022).

While the bulk of EU greenhouse gas emissions is covered by the EU emission trading system (including agreed extensions to buildings and road transport), price mechanisms remain largely absent in agriculture, which is covered under the emission targets set by the Effort Sharing Regulation (ESR). One way to address this issue is to leverage pricing to account for environmental damages related to food consumption. This idea is not novel, as it has been discussed (e.g. in the EU Farm to Fork strategy European Commission, 2020), studied in policy (EC, 2023) and academic contexts (Klenert et al., 2023), recommended by the European Scientific Advisory Board (ESABCC, 2024) and recently proposed for implementation in Denmark. One of the advantages of price-based policy measures, as a market-based instrument, is informational efficiency: the price signal directly represents externalities, reducing the need for consumers and producers to engage in time-consuming assessments of sustainability criteria or comparison of ecolabels. As such, pricing instruments can form a strong component of a broader policy package (Springmann et al., 2018).

However, several concerns stem from the adoption of price measures. One is the competitiveness of the EU agriculture sector. In the absence of a large-scale international coordination or a carbon border adjustment mechanism covering agriculture, greenhouse gas emission taxes on EU producers (i.e. supply-side measures) risk leaving them in a situation of competitive disadvantage vis-à-vis the rest of the world. A related aspect is carbon leakage arising as from foreign producers replacing (greener) EU producers in satisfying domestic and international demand when EU producers are subject to GHG emission taxes while foreign ones are not. In the presence of carbon leakage, domestic efforts to curb emissions are partly offset by increases in foreign emissions. Finally, climate-based food pricing raises concerns about fairness as well. Food, in general, is a necessity, and price increases could risk the accessibility and affordability of food, particularly for households at the bottom end of the income distribution, who typically spend a comparably higher share of their budget on food products (Klenert et al., 2023, Maier and Ricci 2023). In addition to ethical concerns for the situation of low-income households, perceived unfairness of tax reforms may hamper their acceptability (see Klenert et al., 2018 and Maestre-Andres et al. 2019 for a discussion).

Price measures targeted to the demand-side based on consumption taxes might alleviate competitiveness and carbon leakage concerns as they apply to all products consumed domestically, regardless of their origin. Although demand-side measures may face challenges similar to supply-side GHG pricing in terms of distributional impacts, earlier work has illustrated that fairness concerns can be addressed through revenue recycling (Rausch et al., 2011). Particularly, it has been argued that 'feebates' (blend of fee and rebate) might be a cost-effective instrument that enhance acceptability (Parry, 2021). Feebates represent a revenue-neutral change in taxes, combining higher tax rates for environmentally harmful products with reduced tax rates (or subsidies) for goods or sectors with low emission intensity. While feebate scenarios for food products are emerging in the literature (e.g. Springmann et al., 2017), research on the distributional impacts of food pricing reforms remains scarce (see Klenert, Funke and Cai 2023).

In this paper, we undertake a two-fold analysis. Firstly, we provide a comparative assessment of equivalent demand-side and supply-side GHG pricing quantifying their impact on demand, supply and emissions. We analyse the extent to which substitution effects via international trade as well as emission leakage shape the environmental impact of different reforms as well as their effects on the competitiveness of the EU agricultural sector. Secondly, we present an assessment of a Value Added Tax (VAT) reform designed to reflect the greenhouse gas emissions. We regard this reform that leverages existing VAT rates as a real-world, implementable, correspondent of a full-blown consumption-side tax that fully reflects GHG emissions associated with each food product. We explore the distributional consequences within and across household income groups and consider compensation mechanisms to offset potential regressive impacts.

Our key findings indicate that the harm to the EU agricultural sector's competitiveness and carbon leakage resulting from supply-side price measures would be significant unless these measures are widely adopted internationally. In particular, we estimate that an EU-only supply-side GHG tax of EUR 100 per tonne of carbon dioxide equivalent (tCO_2e) would cause domestic production to fall by about one-third more than domestic consumption as foreign producers replace EU ones. Moreover, given foreign producers are generally "less green", this would come with a carbon leakage amounting to 42% of the emissions reduction achieved in the EU - hence severely frustrating its climate effort. By contrast, our proposed VAT tax reform can reconcile competitiveness, climate and equity concerns when combined with complementary measures. Indeed, since VAT equally applies to EU and foreign producers selling in the EU, this reform would level the playfield in the Single Market and generate positive carbon leakage. From an equity standpoint, while this measure is regressive, a feebate or equal-per-capita cash transfer scheme can address equity concerns. Indeed, these compensation measures would produce welfare gains for the majority of the population, while the top 20-30% of meat consumers experience small welfare losses. However, our results further indicate that VAT reforms would bring a limited 2-3% reduction in GHG emissions. That is because producers shift output to export markets and the policy does not offer direct incentives to farmers to innovate. Accordingly, complementary trade measures should be considered to enhance the environmental effectiveness of demand-side pricing.

This analysis goes beyond existing literature by taking real-world policy instruments (VAT) as the point of departure, by considering trade impacts, and by providing an in-depth view of

heterogeneous impacts across different households and countries. We do so by representing the diversity in existing tax systems and (emission intensities of) dietary patterns in a broad geographical scope of the EU, including Spain, France, Poland and Romania. These countries are among the most populated and highest meat consumers Member States while presenting a significant degree of heterogeneity in terms of GDP per capita. Moreover, they currently feature comparably low VAT rates on GHG-intensive food products (as necessity goods), therefore the environmental pricing of food products is likely to cause distributional concerns due to consumption patterns across income groups. Importantly, our analysis also considers the horizontal equity aspect. This is key to inform about the scope for advocacy groups to mobilize consumers that are homogeneous along non-income dimensions, such as meat-based dietary patterns.

The rest of the paper is structured as follows. Section 2 introduces the material and methods, presenting the models we employ in our analysis, the data underpinning them as well as the construction of the policy scenarios we consider. Section 3 illustrates the results of our analysis by discussing the simulated impact of these policies on prices, production and emissions. Furthermore, it provides an extensive discussion of the distributional implications and policy design options to address equity concerns. Section 4 provides some conclusions.

2. Material and methods

Addressing our research question requires detailed modelling of the agricultural sector in each country and its interconnections with the rest of the world to analyse the impact of any reform on domestic production, trade, and emissions. Moreover, we need microdata on consumption to explore the heterogeneous effects of our proposed reform across households and countries. Finally, we need a thorough and integrated modelling of the tax and benefit systems to reflect the existing consumption tax policy and to model its reform.

In this section, we discuss the methodology and data underpinning our analysis. In Section 2.1, we describe the agro-economic model, CAPRI, which allows us to model the impact of supply-side and demand-side measures on the agricultural sector and the emissions it generates, crucially accounting for the role of international trade. Alongside this, we present our microsimulation suite, EUROMOD, which allows us to model the redistributive impact of our proposed VAT reform in the EU countries. In Section 2.2, we offer a discussion on the difference between supply-side and demand-side taxes on emissions– which we will then quantify in our subsequent analysis. We then argue how our proposed VAT reform can be regarded as an implementable, real-world policy counterpart of a full-blow consumption tax on GHG emissions on agricultural products. We therefore construct the relevant VAT reform scenarios and compensation mechanisms.

Given the numerous shocks occurring from 2020 to date, from the COVID-19 pandemic to the cost-of-living crisis, we opted to model our reform scenarios with respect to the baseline year of 2019. In this way, we can abstract from the impact of these shocks – and crucially the policy responses to them which included significant price measures (see Amores et al., 2023) – from our results.

2.1 Modelling framework

The CAPRI model

The CAPRI (Common Agricultural Policy Regionalised Impact) modelling system is an agro-economic, partial equilibrium model, where the impacts of different agricultural, climate change, environmental and trade policies on agricultural production, farm prices, and income, trade as well as environmental indicators are analysed in a comparative-static framework (Britz and Witzke, 2014). The model comprises two interacting modules, a supply module for Europe and a global market module where bilateral trade and prices for agricultural commodities are computed when they interact in an iterative process until equilibrium is reached. The supply model considers a profit-maximization of representative regional farms in the European Union and candidate countries, taking into account constraints related to land availability, nutrient balances for cropping and animal activities, and policy restrictions. The market module consists of a global multi-commodity model for about 60 primary and processed agricultural products, covering 77 countries in 40 trading blocks. Bilateral trade flows and attached prices are modelled based on the Armington assumption of quality differentiation. The behavioural functions in the market model represent supply and demand for primary agricultural and processed commodities (including human and feed consumption, biofuel use, import demand from multilateral trade relations), trade balancing constraints, and agricultural market policy instruments (that is, import tariffs, tariff rate quotas, producer and consumer support estimates).

Given the detailed technical information on inputs and outputs, CAPRI allows to compute indicators for GHG emissions such as Nitrous oxide (N_2O) and methane (CH_4), based on the IPCC (2006) tier 2 methodology. It also takes into account detailed technical and management-based GHG mitigation options for EU agriculture (Pérez Dominquez et al., 2020). GHG emissions in the market model are estimated based on Food and Agricultural Organization (FAO) GHG emission inventories on a commodity basis. GHG mitigation in non-European countries is represented by a change in emission factors and a matching change in output prices to reflect the increase in cost, derived from mitigation cost functions from the literature (Lucas et al., 2007). In terms of the database, the European data are mostly sourced from Eurostat, while the international data are mostly from the FAO Supply and Utilization Accounts, supplemented by topic-related sources.

EUROMOD and the extension to Consumption Taxes

To estimate the redistributive impact of the proposed VAT reform we use the recent extension of EUROMOD to Consumption Taxes.[2] EUROMOD is the European Union tax-benefit microsimulation model. It combines country-specific coded policy rules with households microdata (mainly from the European Union Statistics on Income and Living Conditions database, EU-SILC) to simulate tax liabilities and cash benefit entitlements. EUROMOD simulations therefore consider the role played by each tax-benefit instrument and their interactions and generate disposable household income (i.e. income after direct taxes and cash benefits).

To simulate consumption tax liabilities, the consumption tax extension combines the underlying microdata of EUROMOD with household expenditure information for around 200 commodity categories following the imputation procedure described in Akoguz et al. (2020). These mainly come from the harmonised Eurostat Household Budget Surveys (EU-HBS) from the 2010 wave. Starting from the household disposable income simulated by EUROMOD, the consumption taxes extension applies the rules in place in each country (i.e. VAT, specific and ad valorem excises) to simulate post-consumption tax household disposable income, i.e. income after direct taxes, cash benefits, and consumption taxation.

2.2 Policy scenarios

Supply-side vs demand-side price measures: basic intuition

Supply-side and demand-side tax measures can play a significant role in promoting more sustainable food systems. Both are based on the principle of inducing changes in behaviour through changes in prices. Supply-side tax measures, like a GHG tax, target producers by imposing disincentives on the production of polluting food items based on their carbon footprint. This tax directly affects the producers and potentially influence their production choices as well as the adoption of cleaner technologies as it targets the emissions of the specific production technology. For instance, a GHG tax on livestock production could encourage farmers to adopt more sustainable practices, such as using feed additives that reduce methane emissions or adopting regenerative farming techniques. The GHG tax imposed on unabated emissions can indirectly influence consumer choices, but only to the extent the costs are passed onto the final consumer price.

Demand-side tax measures, on the other hand, focus on consumers directly by increasing the price of high polluting food items through consumption taxes based on their average GHG content. This tax would directly affect the consumers and potentially influence their consumption choices, leading to a reduction in demand for polluting food items. For example, a consumption tax on meat based on its GHG footprint can disincentivize consumers from purchasing high-polluting products, as the price increase would make them less attractive. However, consumption-based pricing does not directly incentivise individual farmers to adopt cleaner technologies and management practices, as their products would face the same tax regardless of farm-level emissions.

While both types of measures aim to reduce emissions, their implications for producers differ substantially when accounting for international trade and heterogeneous climate policy stringency across countries. A unilateral EU GHG tax would reduce the competitiveness of European producers by increasing producer prices and generating a partial substitution towards foreign producers. That in turn reduces EU producers' output and raises emissions outside of the EU (carbon leakage). By contrast, demand-side price measures would apply to all products sold in the EU, regardless of their origin. Accordingly, it would leave intact the competitiveness of European producers and, given the size of the EU market, would generate positive spillovers to the rest of world in the form of reduced emissions outside of EU. However, emissions related

to food products that are exported outside the EU are not covered, as consumption-based pricing applies to products sold domestically.

In the following, we define (statically) equivalent supply-side and demand-side taxes GHG on emissions whose quantitative implications in terms of production, consumption, and emissions we explore using CAPRI in section 3.1. We then discuss the construction of a demand-side, real-world reform that leverages existing rates of VAT in each country in our analysis. This reform acts on the demand side, hence maintaining EU producer competitiveness and avoiding carbon leakage, while limiting administrative complexity. For all these reasons, this will constitute our proposed reform whose acceptability we will aim to test analysing its horizontal and vertical distributive impact, in Section 3.2, together with the possibility of correcting adverse outcomes through compensation measures.

Equivalent supply-side and demand-side taxes on GHG emissions

Consider a consumption tax that mimics the static effect of a carbon tax of EUR 100 per tCO_2e. This level corresponds to the one that would broadly align the taxation of food system emissions with the carbon price implied by the existing Emissions Trading System (ETS). In a static, full pass-through environment, such a consumption tax represents the demand-side equivalent of a GHG tax levied on the supply side of the market.

Under full pass-through to consumer prices (p^P), the rate of consumption taxation (t) implied by the GHG tax (*GHGtax*) is simply the one that ensures the same variation in consumer prices and that, hence, implies the same amount of taxation. Letting the subscript "0" to indicate pre-reform prices and taxes and the subscript "1" to indicate their post-reform counterparts, and given producer price (p^P) and consumer price (p^c), this relation can be formally expressed as:

$$p_1^c = (1 + t_1)p_0^p = (1 + t_0)\left(p_0^p + GHGtax\right) \quad (1)$$

After straightforward manipulations, we can re-adjust the above to obtain a direct mapping between the carbon tax and the corresponding change in consumption tax (Δt) that implies the same variation in consumer prices, i.e.:

$$\Delta t = \frac{GHGtax(1 + t_0)}{p_0^p} \quad (2)$$

Given differences in greenhouse gas emissions across products, a consumption tax based on the application of equation (2) would result in a large number of different rates across products, as it can be appreciated in Table 1 below (see "Cons. tax reform"). The imposition and auditing of such a large number of rates makes this reform administratively very costly and, therefore, of little practical relevance.

Our (implementable) VAT reform scenario and related compensatory measures

Our proposed VAT reform leverages existing VAT systems by reallocating VAT rates to the various food items such that these are taxed at the rate which is the closest to the one implied by the GHG tax-equivalent consumption tax reform in equation (2). The closest existing VAT rate

is, in each case, the one that minimizes the absolute distance between existing VAT rates in each country and the GHG tax equivalent implied by equation (2). Resulting rates are again set out in Table 1 (see "VAT reform").

Table 1: current VAT rates, VAT rates implied by the carbon tax and proposed VAT reform (in %)

	ES				FR				PL				RO			
	Current VAT rate	Cons. tax reform	VAT reform	Feebate	Current VAT rate	Cons. tax reform	VAT reform	Feebate	Current VAT rate	Cons. tax reform	VAT reform	Feebate	Current VAT rate	Cons. tax reform	VAT reform	Feebate
Sheep/goat	10	**28.9**	**21**	**21.0**	5.5	**23.6**	**20.0**	**20.0**	5	**23.0**	**23**	**23.0**	9	**23.0**	**19**	**19.0**
Beef	10	**27.2**	**21**	**21.0**	5.5	**22.0**	**20.0**	**20.0**	5	**21.4**	**23**	**23.0**	9	**26.0**	**19**	**19.0**
Pork meat	10	**12.9**	10	10.0	5.5	**8.2**	**10.0**	**10.0**	5	**7.7**	**8**	8.0	9	**11.8**	9	9.0
Poultry meat	10	**11.4**	10	10.0	5.5	**6.8**	5.5	5.5	5	**6.3**	5	5.0	9	**10.4**	9	9.0
Rice	4	**6.6**	4	4.0	5.5	**8.2**	**10.0**	**10.0**	5	**7.7**	**8**	**8.0**	9	**11.8**	9	9.0
Eggs	10	**10.8**	10	10.0	5.5	**6.3**	5.5	5.5	5	**5.8**	5	5.0	9	**9.8**	9	9.0
Milk & cheese	10	**12.8**	10	10.0	5.5	**8.1**	**10.0**	**10.0**	5	**7.6**	**8**	**8.0**	9	**11.8**	9	9.0
Fish & seafood	10	10.0	10	10.0	5.5	5.5	5.5	5.5	5	5.0	5	5.0	9	9.0	9	9.0
Vegetables	4	**4.2**	4	**2.5**	5.5	**5.7**	5.5	**0.2**	5	**5.2**	5	**2.8**	9	**9.2**	9	**8.2**
Bread & cereals	4	**4.5**	4	**2.5**	5.5	**6.0**	5.5	**0.2**	5	**5.5**	5	**2.8**	9	**9.5**	9	**8.2**
Fruit	4	**4.1**	4	**2.5**	5.5	**5.6**	5.5	**0.2**	5	**5.1**	5	**2.8**	9	**9.1**	9	**8.2**
Potatoes	4	**4.3**	4	**2.5**	5.5	**5.8**	5.5	**0.2**	5	**5.3**	5	**2.8**	9	**9.3**	9	**8.2**
Oils & fat	10	**10.6**	10	10.0	5.5	**6.1**	5.5	5.5	23	**23.7**	23	23.0	9	**9.6**	9	9.0
Sugar	10	**10.1**	10	10.0	5.5	**5.6**	5.5	5.5	8	**8.1**	8	8.0	9	**9.1**	9	9.0

Comparing current VAT rates currently applied to food products in Table 1, against those implied by the consumption tax and by our proposed VAT reform evidence a few aspects. Firstly, while all countries in our analysis apply reduced VAT rates to (most) food products, these rates are higher in Spain and in Romania and generally twice the level of France and Poland. Moreover, with the exception of oil and fats in Poland, no food item was taxed at the standard rate in the year of our analysis, i.e. 2019. Secondly, as anticipated in the previous section, significant heterogeneity in the emissions generated by different food products means that the rates implied by the consumption tax are many and rather dispersed. By contrast, our VAT reform – that leverages existing VAT rates – produces only three (in Spain, France, and Poland) or two (in Romania) different VAT rates depending on those foreseen by the legislation of each country and the level at which these are currently set for these products. Because of this administrative simplicity, we regard this as an implementable, real-world, reform.

Overall in our proposed VAT reform, sheep and goat meat and beef are prescribed the highest VAT rates in all countries, given high emission intensities. Whereas, on the opposite, vegetables, cereals, fruit, and potatoes are prescribed the lowest. Given the high share that food consumption represents in the basket of poorer households (see, e.g, Maier and Ricci, 2023) and the fact that the proposed VAT reform generally implies an overall increase in their taxation, this reform risks being regressive. Therefore, in our distributive analysis, we consider two alternative compensatory measures based on revenue recycling. In the *Feebate* scenario, VAT rates on food products with low greenhouse gas intensity (Vegetables, Bread & cereals, Fruit, and Potatoes) are decreased until reaching budget neutrality (as quantified in EUROMOD). In the *Lump sum*

recycling scenario, the additional government revenues generated by the VAT reform are redistributed with an equal lump sum cash transfer to each individual (including children). Under the lump sum transfer scheme, VAT rates are the same as in the proposed VAT reform, whereas VAT rates under the Feebate schemes differ for the low emission-intensity food products. VAT rates implied by the Feebate scheme are also reported in Table 1.

A summary of the various policy scenarios, and their use in the paper, can be furthermore found in Table 2 in the Appendix.

3. Results

In this section we present the results of our analysis. We begin, in Section 3.1, by contrasting and quantifying the effects on prices, output, and emissions of supply-side and demand-side taxes on GHG emissions as simulated in CAPRI. We discuss the role of competitiveness and international trade in determining the different mechanisms underlying these types of reforms and in shaping the aggregate outcomes they produce. In Section 3.2, we then address equity concerns related to the implementation of our proposed demand-side reform (and associated revenue recycling options), analysing their impact on horizontal and vertical inequality using EUROMOD.

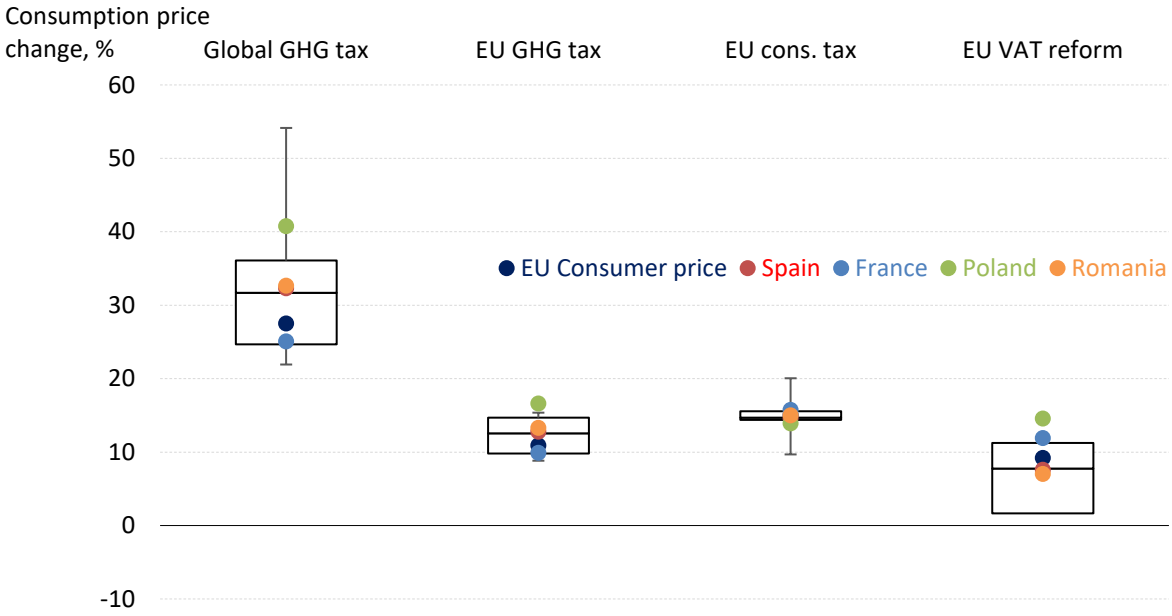
3.1 Impacts of supply- and demand-side price measures: Prices, quantities, and emissions

Effects on price, production and consumption

Figure 1 and Figure 2 present the impact on the price, consumption, and production of beef of a GHG tax of EUR 100 per tCO_2e on producers (i.e. the "GHG tax") alongside the corresponding consumption tax on consumers (i.e. the "EU cons. tax").[3] These reforms are equivalent in the sense discussed in Section 2.2, i.e. they imply the same amount of taxation per GHG emissions (EUR 100 per tCO_2e) although on different sides of the market. To highlight the role played by international trade, we include both the case where the carbon tax is adopted worldwide (i.e. the "Global GHG tax") as well as the case where it is adopted in the EU alone (i.e. the "EU GHG tax"). We contrast these headline reforms to inform on the differences between supply- and demand-side taxes, as well as to serve as a benchmark against which to compare the effects of our proposed reform of EU VAT (i.e. the "EU VAT reform"). We choose the reference case of beef to characterize the different impact of these measures since beef is the most polluting food item by volume of consumption.

[3] For detailed results, see also Table 3 and Table 4 in the appendix of this paper.

Figure 1. Beef price impacts across countries and scenarios



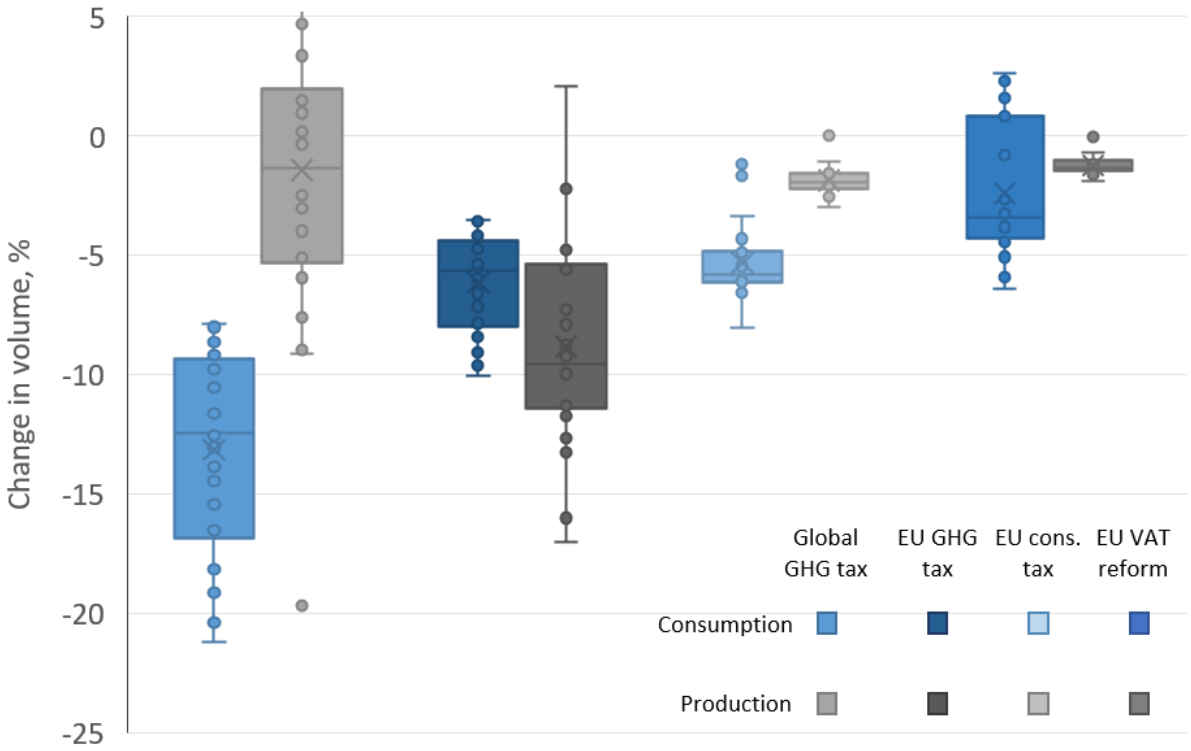
Notes: Box-whisker plots showing the distribution of beef consumer price impacts across countries (and EU average) as computed in CAPRI for different policy scenarios.

A global GHG tax would increase beef prices in EU countries by 25-41%. That is more than in any other scenario since a global GHG tax leaves consumers and producers with no opportunities to avoid the tax via international trade. The impact on prices is also higher than what would result from a static calculation that multiplies GHG content with EUR 100 per tCO_2e, because of the equilibrium effects generated by a falling worldwide production causing prices to rise beyond the level statically implied by the tax. By contrast, an EU-only GHG tax, would leave imported agricultural products unaffected, allowing international trade to act as a buffer to satisfy the EU demand for carbon-intensive goods. In this scenario, beef meat prices, while still increasing substantially, would experience less than half of the increment generated by a worldwide reform because the reduction of global production is lower compared to the global-GHG tax.

On the other hand, if the same GHG tax of EUR 100 per tCO_2e was implemented via an EU consumption tax based on carbon content (as per equation (1)), beef prices would increase by about 15% in the EU. This is slightly larger than in the EU-only GHG tax, since both domestically produced and imported goods would be subject to the scheme. Accordingly, EU consumers would not be able to avoid the tax by substituting EU-produced beef with foreign-produced beef. However, when constraining such a consumption tax reform to use only existing VAT rates, as in the EU VAT reform, beef prices would increase – on average - by a more moderate 8%. Indeed, while an EU VAT reform would imply in all countries in our analysis the taxation of beef to increase from the current reduced VAT rate to the standard rate, this increase is generally insufficient to meet the one required by an equivalent consumption tax.

In Figure 2, we can then appreciate the corresponding effects on consumption and production of beef in the EU. Given the negative own price-demand elasticity of beef, the consumption is reduced according to the increase in prices each reform would generate. Therefore, consumption falls the most in the global GHG tax scenarios (on average by 12%) and the least in the VAT reform leveraging the existing system (on average by 4%). On the other hand, the consumption impact is rather similar under the EU GHG tax and the EU consumption tax for their impact on price is similar. The effects on production, however, are less straightforward. EU production falls the most in the EU GHG tax scenario that leaves EU producers in a situation of competitive disadvantage vis-à-vis foreign ones. As a result, EU domestic production falls by about one-third more than domestic consumption as foreign producers replace EU ones in satisfying demand. By contrast, the production impact of a global GHG tax, the EU consumption tax and the VAT reform are similar, on average. That is because, under all these scenarios, EU producer's competitiveness abroad is preserved and even boosted. Indeed, thanks to an emission-efficient production and access to mitigation technologies, compared to rest of the world, the EU agriculture sector could be able to partially offset demand losses due to increased taxation by boosting exports. Consequently, under all these scenarios, EU consumption generally falls more than production.

Figure 2. Beef quantity impacts across countries and scenarios



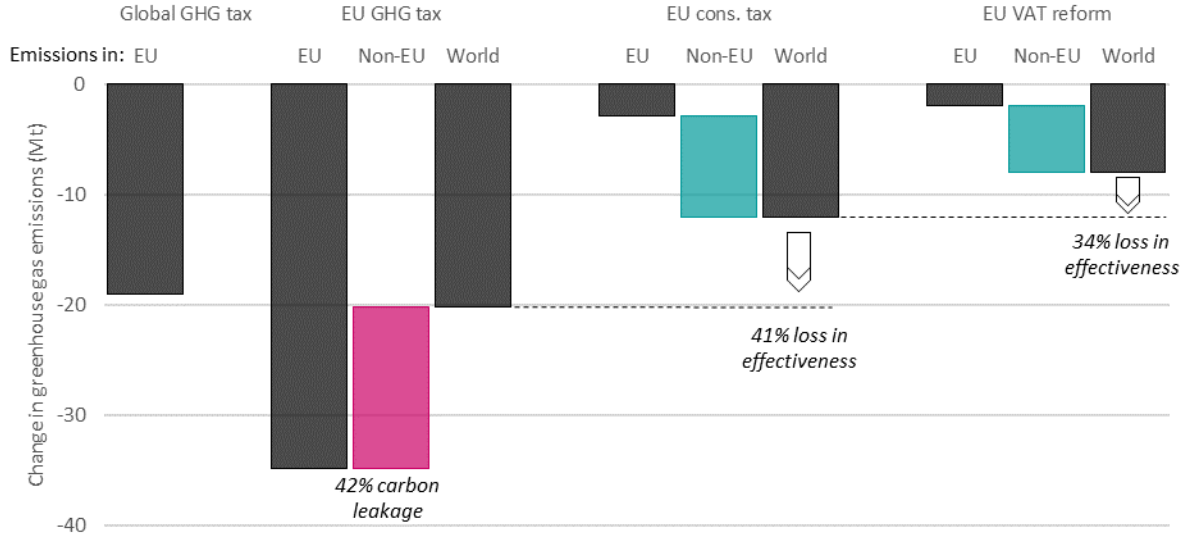
Notes: Box-whisker plots showing the distribution of (a) beef consumption (in blue) and (b) beef production (in gray) impacts across countries as computed in CAPRI for different policy scenarios.

All in all, unless supply-side price measures are widely adopted internationally, which is difficult given the large policy coordination they require and the beggar-thy-neighbour incentives involved, they would harm the competitiveness of the EU agricultural sector. This loss in competitiveness is visible in the EU GHG tax scenario as the fall in domestic production significantly exceeds the fall in domestic consumption. On the other hand, our proposed VAT reform, while producing a more limited reduction in beef consumption, maintains EU producer's competitiveness generating a fall in production largely in line with the one that it would produce in presence of international coordination.

GHG emission impacts

Figure 3 depicts the reduction of GHG emissions in the EU and the rest of the world generated by each of the reforms.[4] Under a Global GHG tax, cleaner production technologies and a reduction in output of high-emitting food products drives down GHG emission in EU by nearly 20 Mt CO_2e (i.e. million metric tonnes of Carbon Dioxide equivalents). Instead, under an EU GHG tax, this reduction amounts to 35 Mt since, as explained earlier, the EU GHG tax does not apply to non-EU producers and the production of the emission-intensive goods outside of the EU (where emission efficiency is lower) would lead to an emission leakage effect as foreign producers replace EU ones. We estimate this carbon leakage to amount to 42% of the emissions reduction achieved in the EU. Hence a significant part of the EU emission reduction effort would be offset, limiting the effectiveness of this reform.

Figure 3. GHG emission reduction (Mt CO2e, compared to baseline) of different policy designs



Notes: absolute changes in agricultural GHG emissions for the EU and World for different policy scenarios as computed in CAPRI. GHG emissions from agricultural production cover most of methane and nitrous oxide agriculture emitting sources. The global GHG tax is estimated to reduce 913 Mt CO_2e globally.

[4] For detailed results, see also Table 6 in the appendix of this paper.

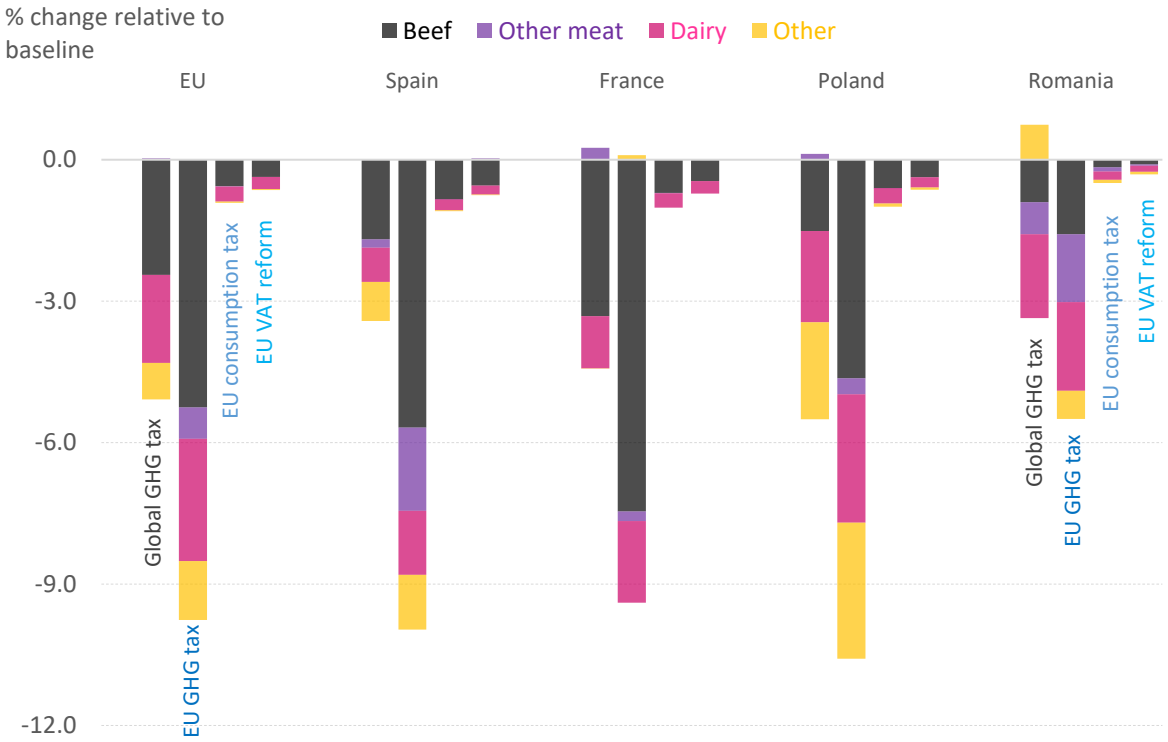
On the other hand, an increase in consumption taxation in the EU generates a larger reduction of GHG emissions abroad than at home and hence implies positive spillovers to the rest of the world. Two mechanisms are at play. First, reduced domestic demand leads EU producers to shift their products to the export market, where products do not face the consumption tax. As EU food products tend to have lower emission intensity than those produced abroad, this reduces non-EU emissions. Second, as the consumption tax also applies to products produced outside the EU but consumed within the EU, the tax lowers the EU demand for foreign, high-emission food products such as meat and dairy. Despite the positive spill over effect on emissions outside of the EU, the EU consumption tax achieves 41% less of the reduction in GHG emissions, compared to the worldwide emissions reduction of an EU-only GHG tax. The reason is that a consumption-based tax does not provide direct incentives to farmers to reduce GHG emissions, as efforts to bring down farm-specific emissions would not be reflected in the tax rate. As such, this measure brings smaller progress towards EU greenhouse gas emission reduction goals, e.g. as specified in the Fit-for-55 package. Furthermore, compared to the fine-grained consumption tax, a coarser VAT reform that uses the existing rate structure of VAT systems limits the GHG impact further by about one-third, suggesting that existing VAT structures imply a straightjacket that hampers the effectiveness of VAT reforms for climate change mitigation.

In summary, EU-only supply-side measures would achieve larger worldwide emission reductions than its consumption-side equivalent, for the latter does not offer direct incentives to farmers to innovate. However, unilateral supply-side taxes leave EU producers in a situation of competitive disadvantage to the rest of the world requiring them to shoulder the whole burden of emissions reduction. On top of it, part of this emission reduction would be frustrated by the carbon leakage from (more polluting) foreign producers who would partly substitute the European ones.

Finally, we analyze the emission impacts in each country in Figure 4.[5] Across countries, the reduction in emissions under the various tax measures is fully consistent with our discussion for the EU as a whole. Under the various scenarios, emission reduction is also comparable in the various countries– except in Romania where it is significantly smaller. That is because the access to emission-saving technologies in Romania is still lower compared to older EU Member States leading to lower emission reductions. For reasons already discussed, everywhere the implementable VAT reform (i.e. the "EU VAT reform") is less effective in curbing emissions but still goes a long way in generating the effects of a full-blown consumption tax on emissions.

[5] For detailed results, see also Table 5 in the appendix of this paper.

Figure 4. Impact on GHG emissions in the EU and selected Member States



Notes: changes in agricultural GHG emissions for different countries and the EU as computed in CAPRI. Impacts are differentiated by different types of food commodities.

3.2 Equity concerns and compensatory measures

In absence of large-scale international coordination, demand-side price measures best reconcile environmental and EU competitiveness instances. Nonetheless, these measures are open to equity concerns. Indeed, food is a necessity good that represents a higher share of consumption in the basket of lower-income households (see on this topic, e.g., Maier and Ricci, 2023). As the recent cost of living crisis has highlighted (see Amores et al., 2024), shocks to food prices have a regressive impact that disproportionately affects poorer households who also have little financial room to shoulder increases in the cost of their consumption baskets. In this section, we therefore explore the distributional consequences of our proposed VAT reform on vertical and horizontal equity. We then consider how adverse distributive outcomes can be addressed by appropriately designed compensatory measures.

The distributional implications of a VAT reform

We undertake our distributional assessment based on a household welfare metric measured in terms of compensating variation at constant quantities. In a nutshell, we measure welfare variation in terms of the extra euros needed to buy the same consumption basket at the consumer prices in the reform scenario. For a formalization of this concept of welfare, we refer to Amores et al. (2024). Here, it is worth stressing that such a welfare analysis provides a first-order approximation of the welfare effects which does not account for demand responses to changes in consumer prices.

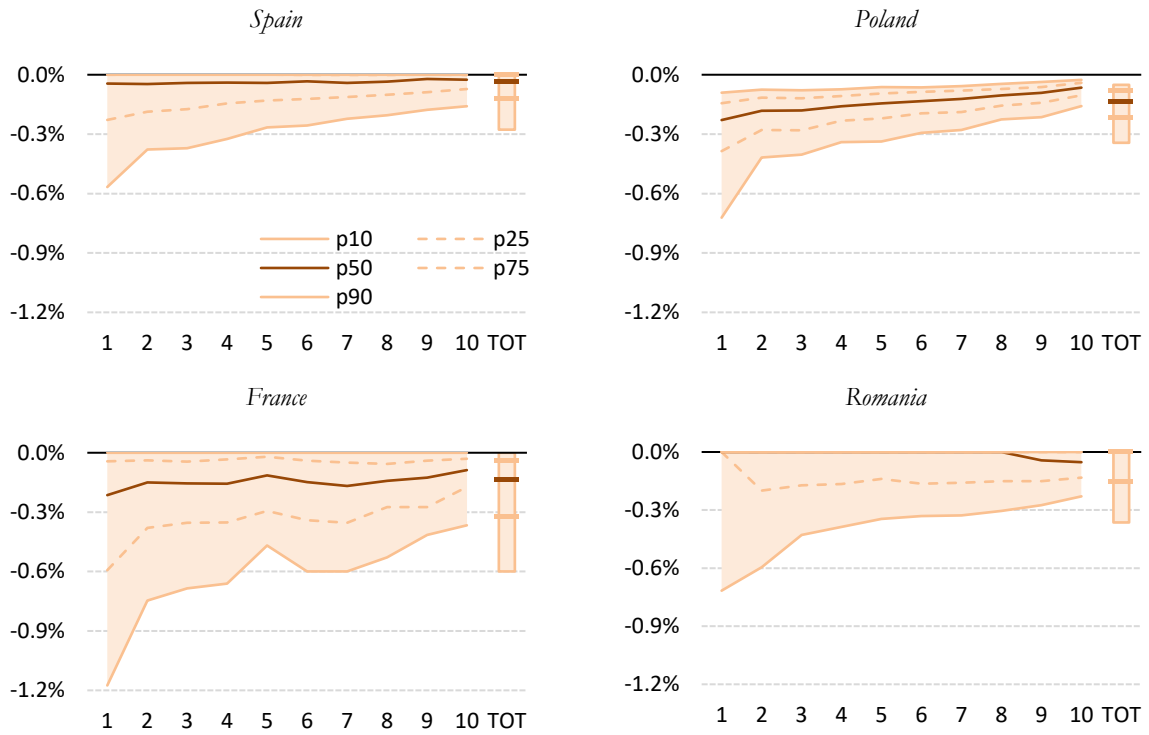
We begin considering vertical equity, by analysing the impact of our proposed VAT reform on household welfare across income deciles. Deciles are constructed for individuals based on equivalent household disposable income. For each decile, we report the median impact as well the spread around that median.[6] Results are presented in Figure 5 with compensating variation expressed as % of baseline disposable income.[7] There, we can appreciate that the impact of our proposed VAT reform is regressive in all countries with the poorest households shouldering the greatest burden. French households in the first decile bear the largest loss of up to 1.1% in disposable income, while in all other countries the impact is about half of it. To make sense of these differences, consider the distance between current VAT rates and those implied by the VAT reform, in Table 1. In the case of France the rate of VAT implied by the reform over the most polluting food items, such as beef and pork meat, is more than 4 times the current one, whereas in Spain and in Romania the change is just half of it.

However, within income groups, the dietary patterns of households are likely to vary due to differences in tastes, household composition, habits, etc. Accordingly, horizontal equity is also a potential source of concern. To dig into this aspect, we present in Figure 6 the welfare impact by deciles of beef consumption as a share of total food expenditure. This figure captures the extent of the impact of this reform ranking households according to their exposition to it, as exemplified by their consumption of beef – one of the food products whose taxation is to increase the most – relative to how much they spend on food altogether. By this ordering, households in the tenth decile are those with the highest relative consumption of beef and, therefore, those who are more likely to be opposed to the proposed VAT reform. Looking at the figure, as expected the magnitude of the impact increases across deciles with worst-affected households being French top meat consumers. However, for the 90% of households in all countries, the excess expenditure generated by the reform does not exceed 1.3% of their disposable income

All in all, our distributional analysis suggests that the impact of our VAT reform on households is generally small. Although with a few exceptions, in the reform scenario households are generally found with a welfare loss corresponding to less than 1.3% of their disposable income.f However, despite its relative small magnitude, the inequality-enhancing direction of the reform remains a concern for a number of reasons. Firstly, because the poorest households are often credit-constrained and consume more than they earn. As such, increases in prices can immediately affect their ability to sustain their material standards. Secondly, because the present reform cannot generate, by itself, all the necessary reductions in emissions needed to achieve the EU climate goals, meaning it needs to be part of a broader package of reforms. In this context, adverse distributional outcomes might compound and become –as a whole– very significant. Addressing the regressivity of any intervention is therefore necessary. In the remaining of our discussion, we therefore consider how the revenues raised by our proposed VAT reform can be used to reconcile climate and equity concerns thanks to appropriately designed compensation measures.

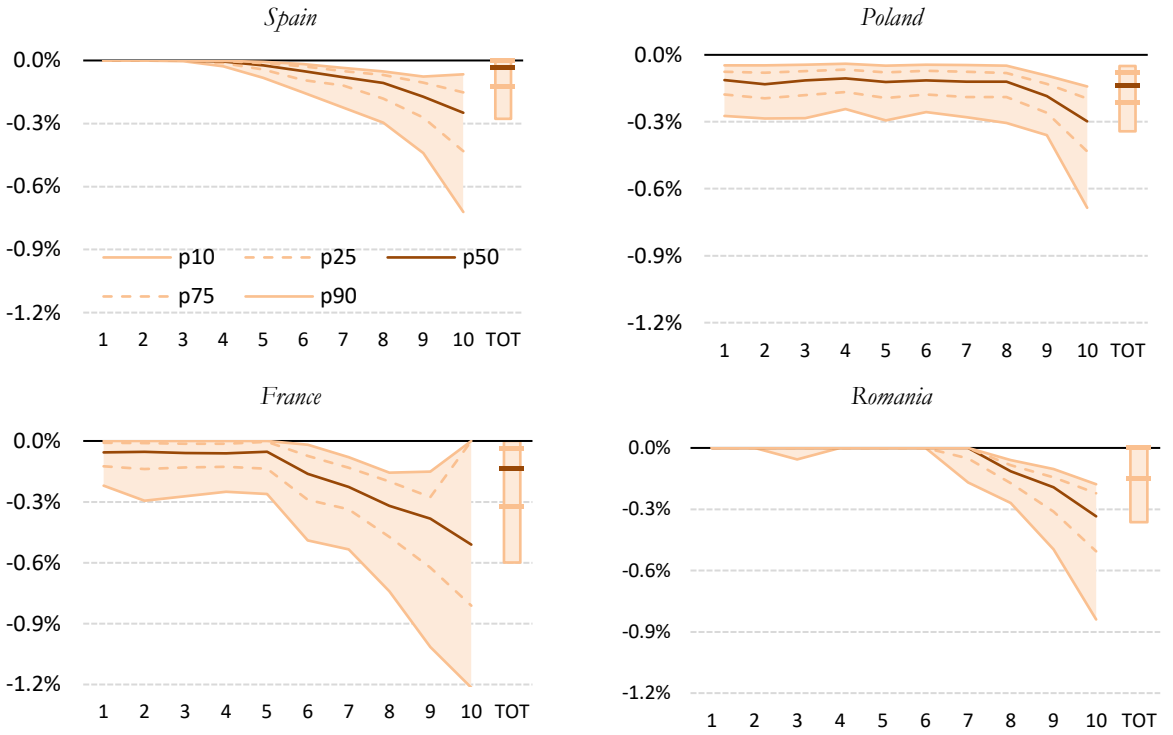
[6] For this purpose, we order within each decile household's based on the welfare impact they suffer under each reform. We then show within each decile the 10th, 25th, 50th, 75th and 90th percentile of the variation in welfare.
[7] For detailed results, see Table 7 in the Appendix of this paper.

Figure 5: Impact of VAT reform on CO_2e intensive food products over households along the income distribution.



Notes: Deciles of individuals ordered on baseline equivalized household disposable income. We show the spread of the individual change in household welfare relative to household disposable income for each decile. Household income is kept fixed at the pre-reform level.

Figure 6: Impact of VAT reform on CO_2e intensive food products over households based on their meat consumption.



Notes: Deciles of individuals ordered on the share of household beef consumption in total household food consumption. We show the spread of the individual change in household welfare relative to household disposable income for each decile. Household income is kept fixed at the pre-reform level.

Revenue recycling and compensatory measures

The distributional analysis indicates that the impact of the VAT reform greening food taxation is expected to be small. Nonetheless, given its regressive nature and the fact that households at the bottom of the income distribution are the most affected, we consider how the revenues from the reform can be recycled to correct this effect. For this purpose, we study two revenue recycling schemes to address vertical equity concerns. The first scheme, which we name "Feebate", consists in combining the increased VAT rates on high emission-intensive food consumption – under our VAT reform scenario - with a decrease in VAT rates on low-emission food products. A second scheme, which we name "lump sum", simply consists in transferring back to households revenues from increased VAT through lump sum transfer.[8] Both these reforms will be revenue-neutral by construction. Their impacts on vertical equity are presented in Figure 7, which shows the effects across the income distribution of both revenue recycling options.[9] On the left-hand side the feebate scheme is considered, whereas on the right-hand side, we show the lump sum transfer.

While results slightly vary across the four countries, we generally find that the feebate system flattens out the losses across income groups to zero, while the lump sum transfer produces a small redistributive effect in favour of the poorest households. Again, we explore whether these averages mask larger heterogeneity within income groups. Accordingly, as in the previous section, we analyse the spread within deciles of the impact of the reforms. The heterogeneity in the impact on the welfare of both reforms, relative to disposable income, is larger for the low deciles. Nonetheless, this remains close to zero under both compensation schemes. We conclude that both types of measures can largely address the small but adverse distributional outcome generated by our proposed VAT reforms. In sum, equity concerns can be addressed whenever this reform is accompanied by appropriately designed compensatory measures.

As anticipated, the main purpose of the compensatory measures is to address the welfare of low-income households and neutralise any regressive effect of the VAT reform. However, the impact on horizontal equity is also worth exploring to gather a sense of the political resistance this reform might encounter. In, we show the impact of the VAT reform on households ordered by relative meat consumption in the presence of both types of compensatory measures. The panels on the left correspond to the feebate scenario, while the panels on the right correspond to the lump sum compensation.

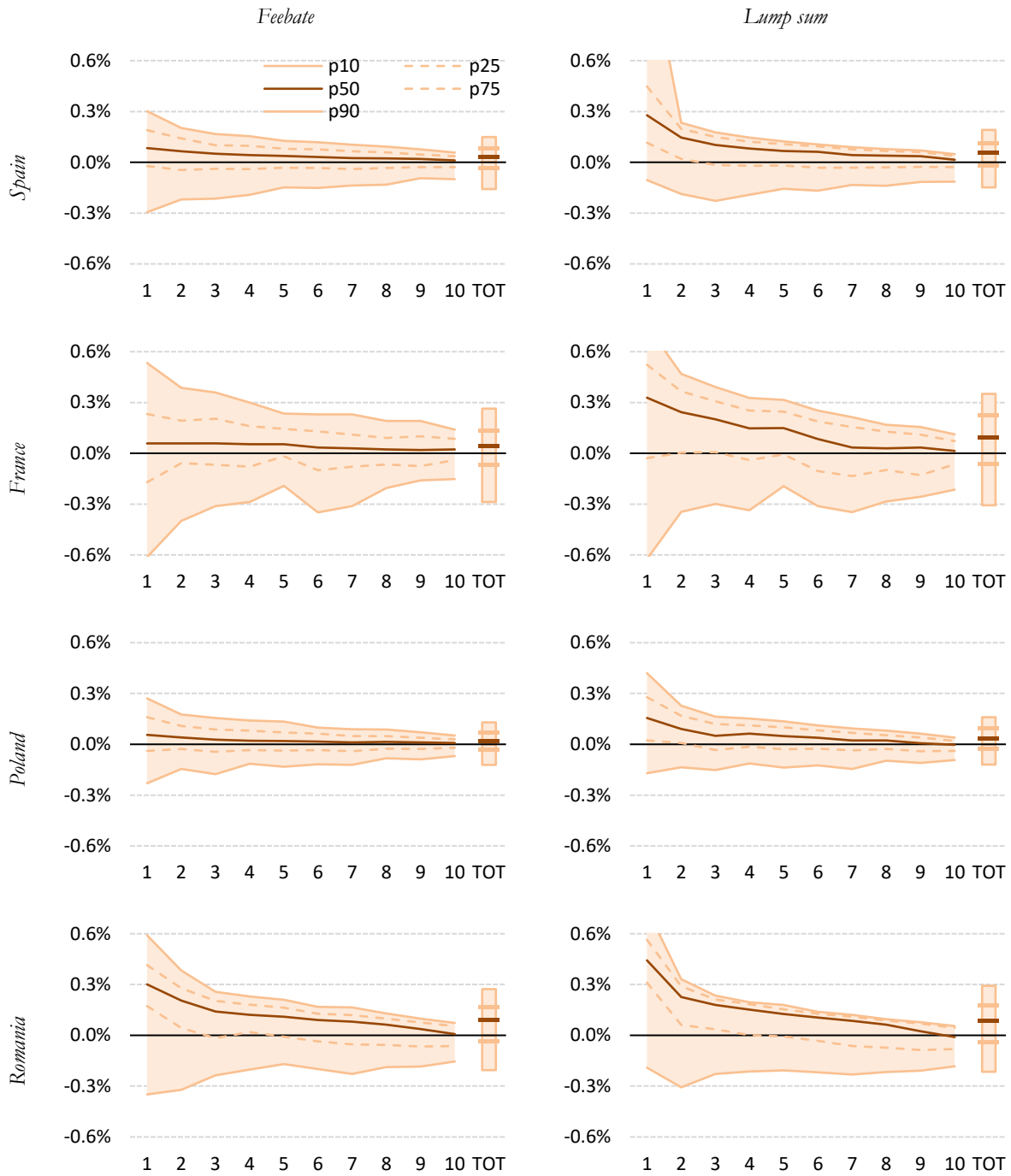
Even though we find in all countries that those that most beef consume, relative to total food expenditure, still experience net losses, their welfare loss is decreased because of the compensatory measures. For example, in Spain, the median welfare loss of the highest 10% of beef consumers is limited to 0,2% of baseline disposable income in the feebate scenario and 0,1% in the lump sum scenario, whereas it was 0,3% without compensation. Nonetheless, the net effect of the VAT reform and both compensation measures is still a redistribution from those households consuming more beef towards households consuming less beef - with the top 20-30% of meat consumers experiencing small welfare losses. For this reason, the main

[8] The lump sum transfer is designed to be given to each individual, including children.

[9] For detailed results, see Table 8 in the Appendix of this paper.

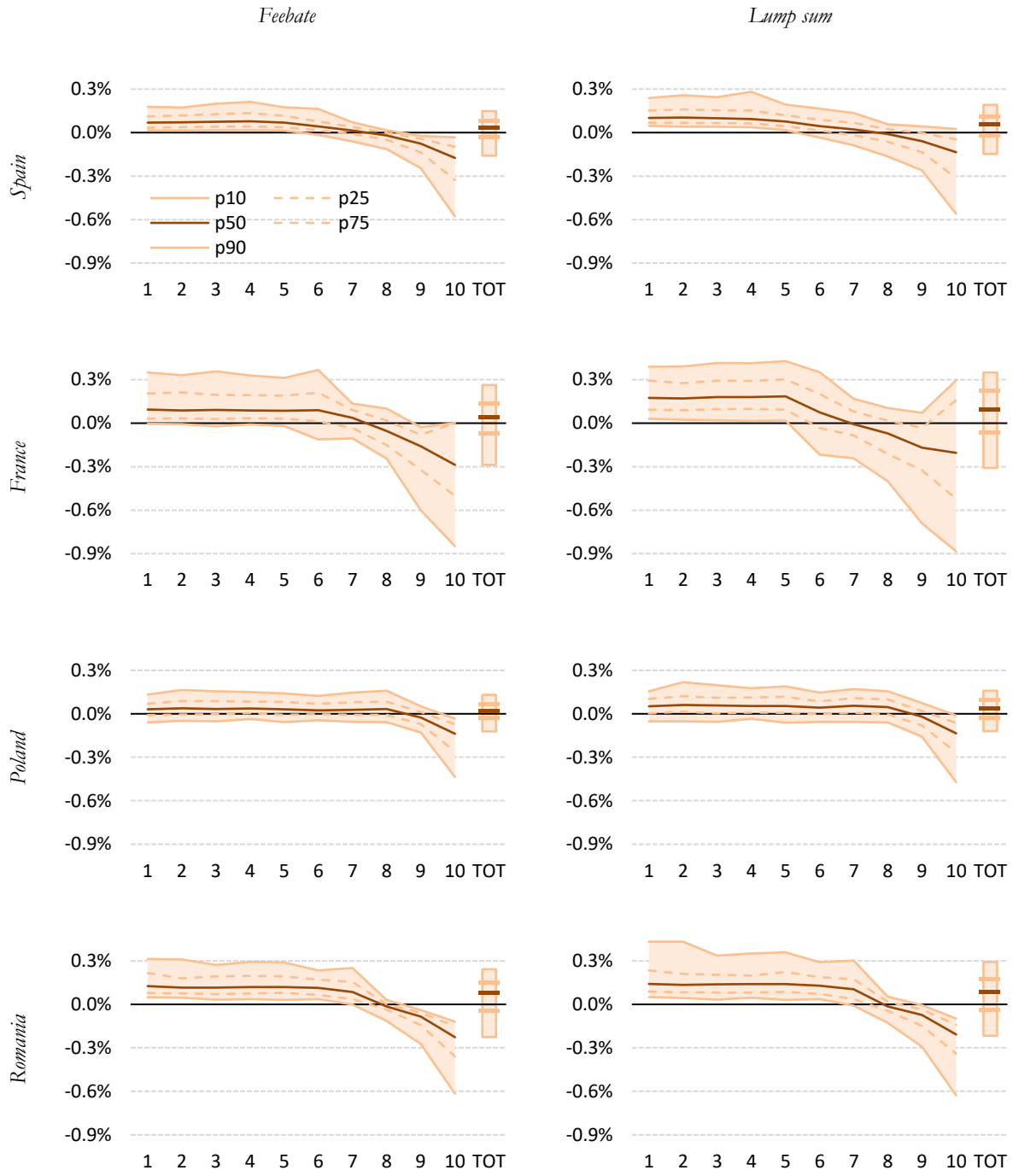
opposition towards greening the food tax system might be expected from those households consuming CO_2e-intensive food products, or the advocacy groups that represent them.

Figure 7: Impact of VAT reform and compensatory measures over households across the income distribution.



Notes: Deciles of individuals based on baseline equivalized household disposable income. We show the spread of the individual change in household savings relative to baseline household disposable income for each decile.

Figure 8: Impact of VAT reform and compensatory measures over households based on their beef consumption.



Notes: Deciles of individuals ordered on the share of household beef consumption in total household food consumption. We show the spread of the individual change in households' welfare relative to household disposable income for each decile. Household income is kept fixed at the pre-reform level.

4. Conclusions

EU climate policy has made substantial advances in addressing emissions related to energy use. Reaching climate neutrality by 2050, however, calls for additional measures to bring down emissions related to food consumption. With socio-political challenges for EU-wide and supply-side measures, governments may turn to domestic, demand-side policies to address emissions from agriculture. We provide a model-based assessment of emerging questions on the effectiveness and equity of such measures, related to carbon leakage (international trade), competitiveness of EU farms, and social acceptability (distributional impacts) of reforms, respectively.

We find that a well-designed VAT reform, that leverages the existing EU VAT system to reflect the greenhouse gas intensity of food products, can generate reductions in emissions in the EU and in the rest of the world while preserving EU producers' competitiveness abroad. This is in contrast to supply-side measures, such as a carbon tax on producers, which can harm the competitiveness of the EU agricultural sector and lead to significant carbon leakage when adopted unilaterally and without complementary trade measures. While being based on a real-world instrument, the VAT reform studied in this paper achieves two-thirds of the emission reductions of a theoretical fine-grained consumption tax based on GHG content. At the same time, demand-side pricing based on GHG content valued at EUR 100 per tCO_2e brings only a 2-3% reduction in GHG emissions as producers shift output to export markets and the policy does not offer direct incentives to farmers to innovate. Achieving larger emission reductions through demand-side pricing would thus require ramping up the tax rates.

Nonetheless, this measure risks raising equity concerns due to the high share of food consumption in the budget of low-income households. Our distributive analysis confirms that the expected impact of this reform – while small – is expected to be regressive. We, therefore, consider two revenue recycling schemes, a feebate scenario, and a lump sum transfer scenario, to address the regressive nature of the VAT reform. We find that both these mechanisms can largely address the small but adverse distributional outcome generated by our proposed VAT reforms, ensuring that equity concerns are addressed whenever this reform is accompanied by appropriately designed compensatory measures. Horizontal equity concerns remain, although our quantification suggests that these are somewhat concentrated in the top 30% of meat consumers. These results indicate that obstacles for implementation based on general, income-based fairness perceptions could be easily overcome, whereas opposition to reform is more likely to arise when advocacy groups are able to mobilize consumers that are homogeneous along non-income dimensions, such as meat-based dietary patterns.

Our assessment contributes to the literature on the effectiveness and acceptability of climate policy, particularly to the work on demand-side measures, international trade and carbon leakage, and greenhouse gas mitigation in agriculture and the food system. More broadly, our study provides a model-based evaluation of concrete policy measures that can help guide our economy to a safe and just space for humanity (Rockström et al., 2023). As such, this paper provides an illustration of 'Doughnut Economics' (Raworth, 2017) in action, by assessing the potential of adjusting existing policy infrastructure (VAT taxes) to limit global warming while considering equity.

Several aspects go beyond the scope of this paper but warrant further attention in follow-up research. First, our results indicate that international trade plays an important role in the effectiveness of policy measures, but the scenarios do not consider changes in trade policy. This could be considered in future work to contribute to the discussion on how trade policy can support environmental goals (Jakob et al., 2022). Second, environmental damages of the food system go beyond climate change, as agriculture also contributes to air and water pollution as well as biodiversity loss. Health impacts induced by the proposed VAT reform is also important aspect to be considered in future work. Broadening the lens beyond climate would inform policies that aim for progress on multiple sustainable development goals. Third, distributional impacts on the income side are not considered here. Yet, the potential impacts on farmers are crucial for the acceptability and equity of policy reforms and deserve further study.

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Appendix

A) Policy scenarios

Table 2: Overview of scenarios and their key characteristics and use

	Point of taxation		Main use in the paper	
	Supply-side	Demand-side	Environmental impacts (GHG)	Distributional impacts
Scenarios				
Global GHG tax	x		x	
EU GHG tax	x		x	
EU consumption tax		x	x	x
EU VAT reform		**x**	**x**	**x**
+ Feebate		x		x
+ Lump sum recycling		x		x

B) Detailed results

Table 3: Beef consumer prices across scenarios and regions

	Beef consumer prices (Euro/t)				
Scenario/Region	Baseline	Global GHG tax	EU GHG tax	EU cons. tax	EU VAT reform
European Union	8 593	10 955	9 529	9 886	9 384
Spain	7 271	9 621	8 198	8 334	7 823
France	9 371	11 721	10 298	10 844	10 486
Poland	5 326	7 497	6 210	6 067	6 100
Romania	6 651	8 822	7 535	7 649	7 118

Table 4: Beef production and consumption across scenarios and regions

	Scenario/Region	Baseline	Global GHG tax	EU GHG tax	EU cons. Tax	EU VAT reform
Production (1000 t)	European Union	6 249	6 118	5 605	6 126	6 164
	Spain	544	549	498	532	535
	France	1 502	1 465	1 335	1 474	1 482
	Poland	508	507	451	496	501
	Romania	72	72	68	71	71
Consumption (1000 t)	European Union	6 054	5 346	5 731	5 668	5 799
	Spain	569	495	535	533	547
	France	1 450	1 272	1 370	1 334	1 365
	Poland	66	52	59	62	62
	Romania	106	97	102	105	106

Table 5: Emissions in CO_2e across scenarios, regions and products

		Net emissions in CO_2e (1000 t)				
	Scenario/Region	Baseline	Global GHG tax	EU GHG tax	EU cons. Tax	EU VAT reform
Beef	European Union	103 548	94 370	83 793	101 446	102 186
	Spain	9 628	9 088	7 808	9 359	9 453
	France	28 096	25 625	22 543	27 570	27 757
	Poland	7 786	7 315	6 347	7 599	7 671
	Romania	1 114	1 023	954	1 098	1 104
Other meat *	European Union	52 065	52 163	49 565	52 027	52 092
	Spain	10 936	10 879	10 370	10 936	10 945
	France	4 833	5 022	4 682	4 828	4 835
	Poland	3 506	3 544	3 401	3 506	3 508
	Romania	2 489	2 421	2 343	2 480	2 486
Dairy **	European Union	154 481	147 459	144 744	153 277	153 496
	Spain	6 699	6 468	6 265	6 627	6 639
	France	28 559	27 734	27 268	28 332	28 366
	Poland	11 441	10 841	10 595	11 340	11 373
	Romania	2 672	2 492	2 482	2 654	2 659
Other ***	European Union	65 742	62 843	61 052	65 639	65 680
	Spain	4 780	4 513	4 408	4 772	4 775
	France	12 939	12 937	13 012	12 948	12 947
	Poland	8 306	7 669	7 412	8 283	8 292
	Romania	3 852	3 927	3 791	3 844	3 847

Notes:
* poultry, sheep/goat, and pork meat.
** butter, skimmed milk powder, cheese, fresh milk products, cream, concentrated milk, whole milk powder, casein, and whey powder.
*** cereals, fruits and vegetables, potatoes, tobacco, oils, sugar and milled rice.

Table 6: Emissions in CO_2e for emission leakage across scenarios

	Net emissions in CO_2e (1000 t)				
Scenario/Region	Baseline	Global GHG tax	EU GHG tax	EU cons. Tax	EU VAT reform
European Union	373 421	354 412	338 621	370 536	371 416
Non EU	5 221 289	4 327 006	5 235 879	5 212 173	5 215 340
World	5 594 710	4 681 418	5 574 500	5 582 708	5 586 756

Table 7: Average impact on welfare (%) by income deciles of consumption tax and VAT reform

	Spain	France	Poland	Romania
1	-0.18	-0.49	-0.32	-0.17
2	-0.13	-0.31	-0.26	-0.19
3	-0.13	-0.27	-0.23	-0.13
4	-0.11	-0.27	-0.20	-0.12
5	-0.10	-0.19	-0.18	-0.09
6	-0.09	-0.24	-0.17	-0.11
7	-0.08	-0.26	-0.16	-0.11
8	-0.08	-0.23	-0.13	-0.10
9	-0.06	-0.19	-0.11	-0.11
10	-0.06	-0.14	-0.08	-0.09
All	-0.09	-0.22	-0.15	-0.11

Notes: Deciles of individuals ordered on pre-reform equivalized household disposable income. An average impact per decile is shown, i.e. the average change in welfare relative to the average disposable income.

Table 8: Average impact on welfare (%) of the VAT reform under alternative compensation schemes

	Spain		France		Poland		Romania	
	Feebate	Lump sum	Feebate	Lump sum	Feebate	Lump sum	Feebate	Lump sum
1	0.02	0.23	-0.08	0.12	0.03	0.13	0.21	0.33
2	0.02	0.08	0.00	0.13	0.00	0.05	0.08	0.08
3	-0.01	0.03	0.03	0.12	0.01	0.02	0.06	0.07
4	0.00	0.02	0.02	0.06	0.02	0.03	0.06	0.06
5	0.00	0.02	0.04	0.10	0.01	0.02	0.07	0.06
6	0.00	0.01	-0.01	0.01	-0.01	0.00	0.02	0.01
7	0.00	0.00	-0.01	-0.03	-0.01	-0.01	0.02	0.00
8	-0.01	0.00	-0.01	-0.03	0.00	0.00	0.00	-0.02
9	0.00	0.00	0.00	-0.03	0.00	-0.01	-0.03	-0.04
10	-0.01	-0.01	0.00	-0.04	0.00	-0.02	-0.03	-0.04
All	0.00	0.01	0.00	0.01	0.00	0.01	0.02	0.01

Notes: Deciles of individuals ordered on pre-reform equivalized household disposable income. An average impact per decile is shown, i.e. the average change in welfare relative to the average disposable income.

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