Setting climate action as the priority for the Common Agricultural Policy: a simulation experiment

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Abstract

In this paper we conduct a simulation experiment to quantitatively assess the impacts of re-allocating budgetary resources within Pillar 1 of the Common Agricultural Policy (CAP) from direct income support to a direct greenhouse gas (GHG) reduction subsidy for EU farmers. Although such a budgetary shift is not foreseen in the current political discussions on the future CAP post 2020, the analysis is motivated by calls for both an increased contribution from the agricultural sector to combat global warming, and a more incentive-based delivery system for direct payments. For the analysis, we apply a partial equilibrium model for the agricultural sector (CAPRI) covering both the EU farming sector with high geographical detail as well as global food commodity markets. An integrated emission accounting for EU agriculture and global agri-food products, as well as optional technological GHG mitigation options for EU farmers make CAPRI specifically suitable for the impact assessment. For the scenario we assess a policy that removes the basic direct payments under Pillar 1 of the current CAP and provides farmers a GHG-saving subsidy instead, without increasing the total budget for direct payments.

A major empirical contribution of the paper is the calculation of budget-neutral subsidy rates for the hypothetical GHG-reduction subsidy, factoring in farmers' supply and technology-adjusting responses to the policy change. The subsidy rates are derived by combining the regional representative farm models of CAPRI with a Newton-Raphson numerical approximation method that guarantees budget-neutrality. We find that a budget-neutral re-allocation of financial resources towards subsidized emission savings can reduce agricultural non-CO_2 emissions by 21% in the EU by 2030, compared to a business-as-usual baseline. Almost two-thirds of the EU emission savings are due to production decreases, and, therefore, part of this GHG reduction is threaten to be offset globally by emission leakage effects. At the aggregated level, the emission-saving subsidy and increased producer prices compensate farmers for the foregone direct income support, but the significant regional differences indicate both an accelerated structural change and heterogeneous income effects in the farm population. We conclude that the assumed regional budget-neutrality condition introduces inefficiencies in the incentive system, and the full potential of the EU farming sector for GHG emissions reduction is not reached in the scenario; leaving ample room for the design of more efficient agricultural policies to combat global warming.

Keywords: Common Agricultural Policy, emission saving subsidy, emission leakage, CAPRI model, climate action

1 Introduction

In November 2017 the European Commission published a communication on the Future of Food and Farming (COM(2017)713), reflecting on its vision on the future of the Common Agricultural Policy (CAP). Although the communication does not go into detail regarding future policy options, it sets the scene for the upcoming CAP reform (European Commission 2017a). The policy concept of the communication must be evaluated in the wider context of the Multiannual Financial Framework (MFF), which is negotiated in parallel with the review and modernization of EU agricultural policie s, and which will determine the financial resources allocated to the CAP (European Commission 2017a). The budgetary pressure on agricultural policies is increasing with new challenges for the EU, such as common defence policy and migration, and the exit of a net contributor to the budget in 2019; all pointing to a decreasing CAP resources in the next financial period. Despite the budgetary prospects, the Commission's communication remains ambitious in improving all three sustainable development dimensions of the CAP: social, economic and environmental. Accordingly, the Commission proposal aims to provide more (benefits) with less (budget).

The communication does not go into detail on how resources should be allocated to the different objectives, but it envisages a revamped delivery system of the CAP, which should reduce administrative costs and align overlapping objectives in the two CAP pillars of the current greening measures. Furthermore, income support should be more dependent on enhanced environmental requirements. A combination of compulsory and voluntary measures would enforce farmers to adopt farming practices that are more beneficial for the climate and environment. At the same time, member states would have more flexibility to fine-tune the environmental measures to their specific agro-economic and agro-environmental conditions. From a climate change perspective it is not clear how this new delivery mechanism would allow for more ambitious contributions from agriculture to meet the emission reduction targets of the EU´s 2030 Climate and Energy framework, a key objective identified in the communication.

In this paper we investigate the potential of a re-prioritized CAP towards increased climate action, looking at the potential contribution of agriculture to further limit global greenhouse gas (GHG) emissions. More precisely, we investigate the possible economic and environmental impacts of shifting financial resources under Pillar I from direct income support to subsidizing emission savings in EU agriculture. In line with the new delivery system sketched in the Commission proposal, the emission saving subsidy we investigate is incentive-based by design, rewarding farmers for reducing their current level of GHG emissions. With our simulation experiment we want to answer the following research questions: To what extent could agricultural non-CO_2 emissions be reduced by a budget-neutral shift towards direct incentives for farmers to reduce emissions? What would be the implications on the viability of the farming sector, including the impacts on agricultural income and competitiveness on global food markets? How much would the EU farming system change due to the simulated re-prioritisation of CAP objectives, including the potential reduction in total agricultural output as well as the induced structural change? What would be the impact at the global scale on agricultural emissions, taking into account the possible leakage of emissions to EU trading partners?

For the analysis we use the Common Agricultural Policy Regionalized Impacts (CAPRI) model, a global partial equilibrium model for agriculture. CAPRI is an interlinked system of mathematical optimization models for agriculture and the primary food processing sectors of the EU administrative

(NUTS2) regions, connected to a global model of agri-food markets. A detailed endogenous GHG accounting scheme links agricultural activities to non-CO_2 (nitrous oxide and methane) emissions, the primary source of agricultural GHG emissions. CAPRI enables us to quantify the economic and environmental impacts of the above hypothetical policy option on EU farmers in detail, with regard to both geographical and sectoral disaggregation. In a comparative static analysis, simulated scenario results for introducing a GHG-saving subsidy for EU agriculture are compared to a business as usual scenario in the mid-term (up to the year 2030).

Regarding the details of the scenario assumptions, a challenging empirical question is how to calculate the unit level of the emission saving subsidy (per tonnes of CO_2 equivalent emissions) so that it satisfies budget-neutrality. With budget neutrality we refer to the assumption that the emission-saving subsidy is to be financed by simply reallocating financial resources of Pillar I, without altering the total CAP budget. To calculate the necessary budget for the incentive-based emission-reduction subsidy, farmers' adjustment in their production must be factored into the calculation of the unit rates for the subsidy. One of the main empirical contributions of the paper is to set up a methodological approach for calculating the budget-neutral level of the GHG-saving subsidy, building on standard profit maximizing behaviour of farmers.

Technically, we repeatedly solve the regional models of CAPRI on a large number of different unit subsidy values, where the selection of the unit subsidies is driven by a Newton-Raphson numerical approximation method. The numerical approximation guarantees budget-neutrality by closing the gap between the necessary budgets for the emission-saving subsidies versus current direct income support. The optimal unit subsidies for GHG-savings, defined for each EU NUTS2 region separately, are then plugged in the complete CAPRI modelling system to also factor in the price feedback from the agri-food markets. That way we implement a fully budget-neutral version of the GHG-saving subsidy system in the EU, with direct links to global agri-food markets.

In a dedicated sensitivity analysis we take a closer look at the inefficiencies that the budget-neutrality condition introduces in EU emission savings. We discuss the regional differences in the environmental performance of the hypothetical emission-saving subsidy system by comparing results to an alternative scenario with uniform EU-wide subsidy rates.

2 Methodological approach and scenario design

2.1 The CAPRI modelling system

For the quantitative assessment, the CAPRI (Common Agricultural Policy Regional Impact Analysis) modelling system is employed (Britz and Witzke 2014). CAPRI is a global, comparative static, partial equilibrium model for the agriculture and the primary processing sectors. Two major components are interlinked in CAPRI via an iterative process: (i) highly detailed and disaggregated supply modules for the EU agricultural sector and (ii) a global market model for agricultural commodities. The set of EU regional supply models are constructed following a Positive Mathematical Programming (PMP) approach. The mathematical programming approach offers a high degree of flexibility in capturing important interactions between production activities and with the environment (Heckelei et al. 2012). Each representative regional farm model maximizes profit under restrictions related to land availability, nutrient balances and policy obligations. The regional supply models are linked with a sequential calibration approach to a global multi-commodity agricultural market model. This interaction between the EU agricultural supply and global markets allows capturing the price feedback to simulated policy changes. The market model is a static, deterministic, partial, spatial model with global coverage, depicting about 60 primary and secondary agricultural products, and covering about 80 countries worldwide. International trade is modelled following according to the Armington assumption, i.e. goods are differentiated by place of origin, covering bilateral trade flows, and setting consumer preferences for import demand according to historical trade patterns. Bilateral import prices are derived by considering trade policy measures at the border, such as tariffs, tariff-rate quotas (TRQs), variable levies and the entry-price system for fruits and vegetables. Some further market measures, such as public intervention and export subsidies, are also implemented, but might be inactive. Linking the market and supply modules allows CAPRI pinning down global market effects on the EU, national and even regional scales (Britz and Witzke 2014). CAPRI is frequently used for the ex-ante impact assessment of agricultural, environmental and trade policy options, such as, for example, EU milk quota removal (Witzke et al. 2009), the expiry of the sugar quota system (Burrell et al. 2014), possible EU trade deals (Burrell et al. 2011), climate change mitigation in the agricultural sector (Pérez Dominguez et al. 2016; Fellmann et al. 2018; Meijl et al. 2018), CAP greening measures (Gocht et al. 2017) and possible future pathways for the CAP (M'barek et al. 2017).

EU agricultural (non-CO_2) GHG emissions for nitrous oxide and methane are model-endogenously calculated in CAPRI based both on the input use and outputs of production activities. Following IPCC guidelines (IPCC 2006), a Tier 2 approach is generally used for the calculation of activity-based emission factors, but where the respective information is missing a Tier 1 approach is applied (e.g. rice cultivation). Leip et al. (2010) and Pérez Domínguez et al. (2012) provide detailed descriptions of the emission inventories in CAPRI. The model includes a set of technological (i.e. technical and management-based) GHG mitigation options for EU farmers, focusing on technological options that are already available or will likely be available at the simulation year 2030. Implementation costs, cost savings, and mitigation potential of the modelled technological mitigation options are mainly based on data from the Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) database (GAINS 2013, 2015; Höglund-Isaksson et al. 2013, 2016), and information collected within the AnimalChange project (Mottet et al. 2015). The level of production activities and the use of mitigation technologies are constrained by various factors, including land availability, fertilization requirements of the cropping systems versus organic nutrient availability, feed requirements in terms of dry matter, net energy, protein, and fiber for each animal (Van Doorslaer et al. 2015; Pérez Domínguez et al. 2016; Fellmann et al. 2018). The technological mitigation options specifically considered in this paper are listed in Table 1, and they can be voluntarily applied by EU farmers in the baseline and the scenarios.

Table 1: Technological GHG mitigation options available for adoption by EU farmers

Sector	Technological mitigation options
Livestock	Anaerobic digestion at farm scale, Low nitrogen feed, Linseed as feed additive, Nitrate as feed additive, Vaccination against methanogenic bacteria in the rumen, and specific breeding programs to increase (i) milk yields of dairy cows and (ii) ruminant feed efficiency
Crops	Precision farming, Variable Rate Technology, Better timing of fertilization, Nitrification inhibitors, Rice measures, Fallowing histosols (organic soils), Increasing legume share on temporary grassland

While emissions of EU agriculture are calculated on a per activity basis in the CAPRI supply model, GHG emissions for the rest of the world are estimated on a commodity basis (i.e. per kg of product) in the market model of CAPRI. Mitigation technologies are not specifically considered in non-EU countries, but technical trends are integrated, e.g. for depicting improved emission efficiency over time, using IPCC Tier 1 coefficients and FAOSTAT emission inventories within a robust Bayesian estimation framework (Pérez Domínguez et al. 2012; Pérez Domínguez et al. 2016).

2.2 Scenario design and unit rates of a GHG-saving subsidy

For the policy scenario, we investigate a policy option that removes decoupled income support under Pillar 1 of the current CAP and, in a budget-neutral manner, provides farmers a GHG-saving subsidy instead. More precisely, we remove the basic payment component of direct subsidies, either applied as Basic Payment Scheme (BPS) or as Single Area Payment Scheme (SAPS) in the member states, which clearly serves direct income support purposes. We keep the greening top-up of Pillar 1, which is paid upon complying enhanced environmental conditions, and we also keep the coupled supports for sectors and regions in competitive disadvantage and the support for farmers in areas with natural constraints, as both are assumed to contribute to the objectives of territorial balance and the maintenance of rural livelihoods.

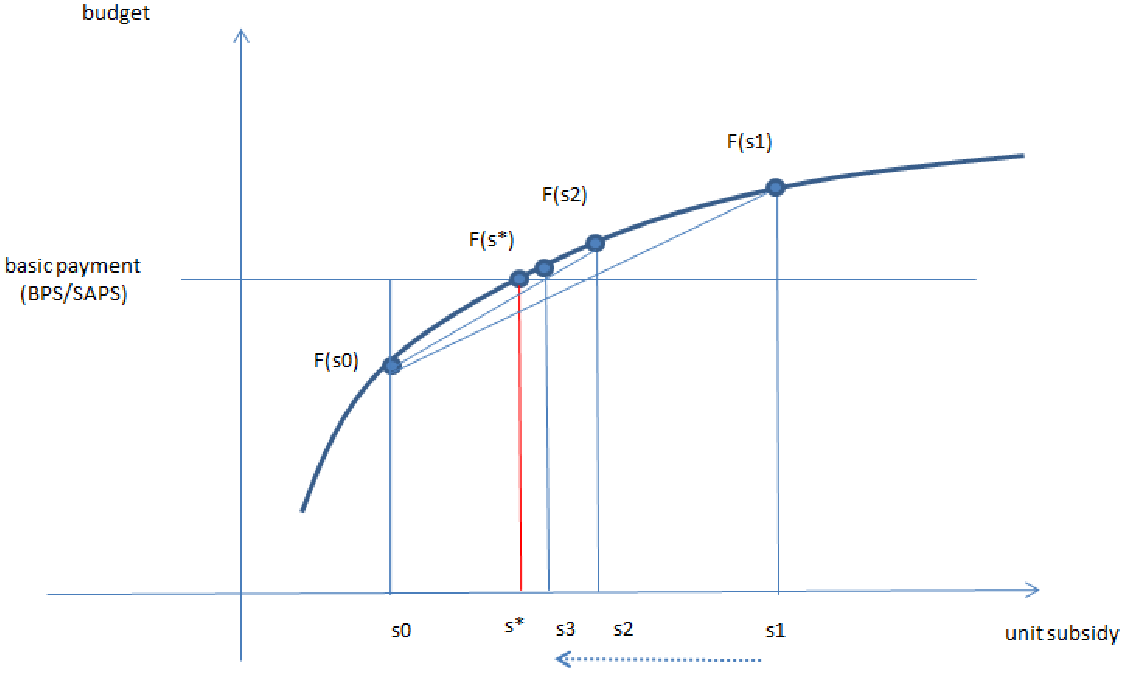
We aim at a fully budget neutral shift of CAP objectives in all NUTS2 regions of the EU, i.e. the GHG-saving subsidy provided to farmers should require exactly the same budget as the current basic payment in the given region. The difficulty we face when implementing an incentive-based policy with the budget-neutrality condition is to calculate the appropriate level of GHG-saving subsidy per tonnes of CO_2 equivalent. To satisfy the budget constraint, we need to factor in the farmers' responses in the calculation of the budget-neutral unit subsidy. We answer this empirical challenge by developing a framework for calculating unit subsidies based on standard profit maximizing behavioural of regional representative farms of the EU.

Farmers' responses to incentivise emission savings are factored in through two main channels in our approach: (1) Farmers can simply cut back agricultural production, what we will refer to as 'production effect' in the following, if the marginal increase in subsidies outweighs the marginal decrease in revenues from production; (2) Farmers also have the possibility to increase their emission efficiency, and therefore collect emission-saving subsidies without decreasing production ('technology effect'). In our modelling approach agricultural producers can adapt emission mitigation technologies from a pre-defined set of technological options (Table 1). The relative size of the marginal cost of adopting a certain mitigation technology compared to the marginal revenue increase from the emission-saving subsidy defines whether a technology option is adopted by farmers and to what extent (summarized in the following discussion as the adoption share of the technology in the region).

Technically we introduce a GHG-saving subsidy in the objective function of the CAPRI representative regional farm models; the subsidy is paid on emission savings relative to initial non-CO_2 emissions from agriculture. A numerical approximation method adjusts the unit level of the GHG-saving subsidy and solves the regional models repeatedly in an iterative manner. The iterative solution process is terminated as soon as the required budget for emission saving subsidies is equal [1] to total initial basic payments, thus satisfying the budget-neutrality condition of the calculation.

Figure 1 gives a visual summary of the approximation approach. Let us define a function $F(s, O)$ for the necessary budget for the GHG-saving subsidy, where s is the unit level of the emission saving subsidy and O represents all other model variables. We cannot give an explicit form for $F(\cdot)$ but can only evaluate the function in selected points $(s_0, s_1 \ldots)$ by repeatedly solving the regional optimization models. Assuming that the unknown $F(\cdot)$ function has no inflection points in the neighbourhood of the theoretical solution s^*, we can numerically approximate the budget-neutral unit subsidy s^*, starting from an appropriate pair of (s_0, s_1).

Figure 1: Newton-Raphson approximation for the budget-neutral unit subsidy rates



By solving the CAPRI regional models repeatedly during the approximation process, we take advantage of the standard CAPRI model features, including a detailed nutrient flow scheme for nutrient availability and requirement of crop and animal production, a nested land-use model and a non-CO_2 emission accounting for agricultural activities. Taking into account also the market feedback and the producer price changes implied by the policy option would require technically a link to the CAPRI market model (which module covers global agricultural commodity markets). The above numerical approximation algorithm then should operate simultaneously in all 226 regional units including also additional iterations for the CAPRI market module. That complication would render the numerical solution infeasible, and therefore we opt for the fix price assumption, i.e. producer prices are fixed during the numerical approximation steps. Nevertheless, the price feedback to the policy changes are taken into account in the final scenario run, when the full CAPRI modelling system is activated and the price response from global agri-food markets are factored in.

[1] In fact the approximation method terminates when the absolute distance between the necessary budget for the GHG-saving subsidy and total initial basic payments is smaller than a pre-defined (small) threshold.

3 Simulation results

In the following section we first report on the estimation of regional budget-neutral GHG-saving subsidy rates, and then we turn to the economic and environmental impacts of the simulated shift of financial resources from basic payment to the EU-wide emission saving subsidy.

3.1 Budget-neutral subsidy rates

The estimated unit subsidy rates show large regional variation in the range of 51 to 711 EUR/t of CO_2 equivalents, with a median value of 198.5 EUR/t of CO_2 eq. (Figure 2). The empirical distribution is skewed to the right, with a few outlier regions with unit rates of more than 500 EUR/t of CO_2 eq.

Regarding the geographical differences across the EU, regions in the new member states, Italy and Greece tend to have higher unit rates (i.e. higher subsidy rates are required per tonne of CO2 eq), while regions in the North tend to have lower scores. Large regional differences can be observed within some countries too, such as Germany, Poland and the UK (Figure 3).

The regional differences can be explained partly by differences in the structure of the current CAP payments (in particular the weight of basic payments in total direct payments) and partly by the production structure that defines the flexibility of the regions to reduce agricultural non-CO_2 emissions. In the regions with larger basic payments relative to total emissions farmers need a larger unit rate in order to arrive at a budget-neutral shift to emission saving subsidies. A simple linear model for the unit rates with the "basic payment per agricultural non-CO_2 emissions" as explanatory variable gives a fairly good fit (Figure 4). This suggests that the opportunity costs of emission-savings clearly increase in all regional representative farms, i.e. the more budget is to be transferred to emission saving subsidies the more the unit rate of that subsidy must be increased.

Figure 2: Budget-neutral rates for the GHG-saving subsidy, all CAPRI regional units

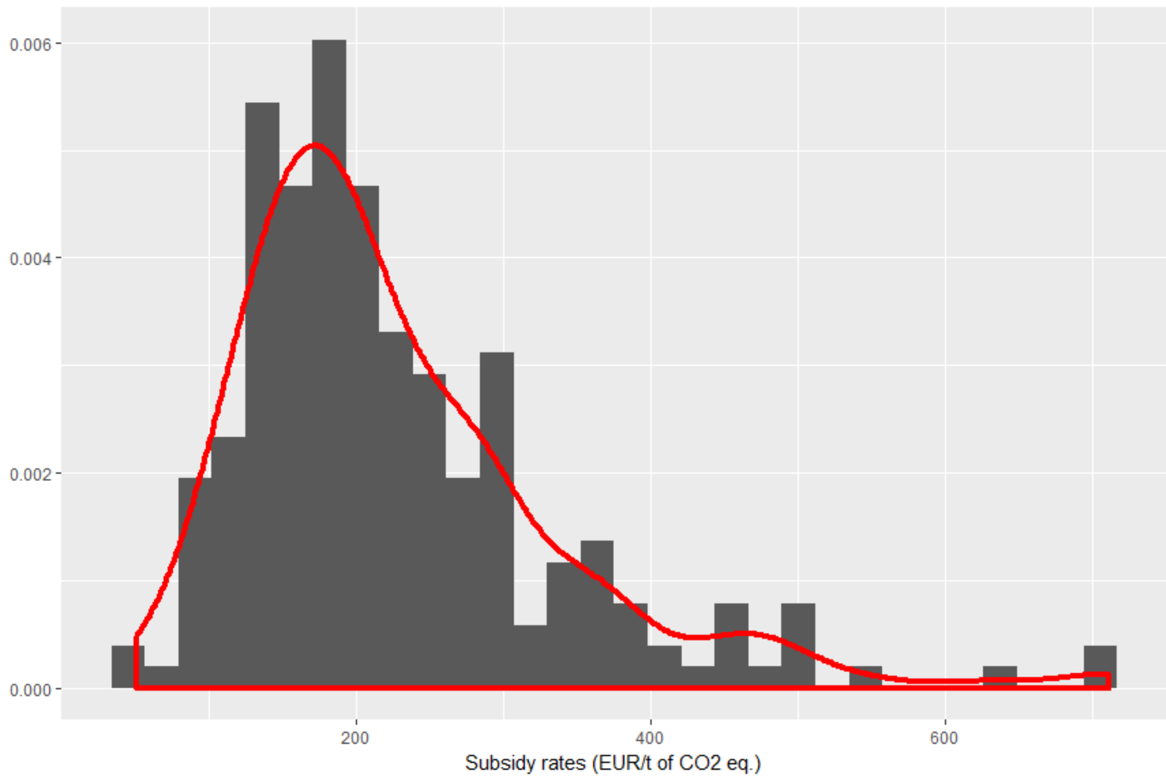


Figure 3: Regional distribution of budget-neutral unit subsidy rates

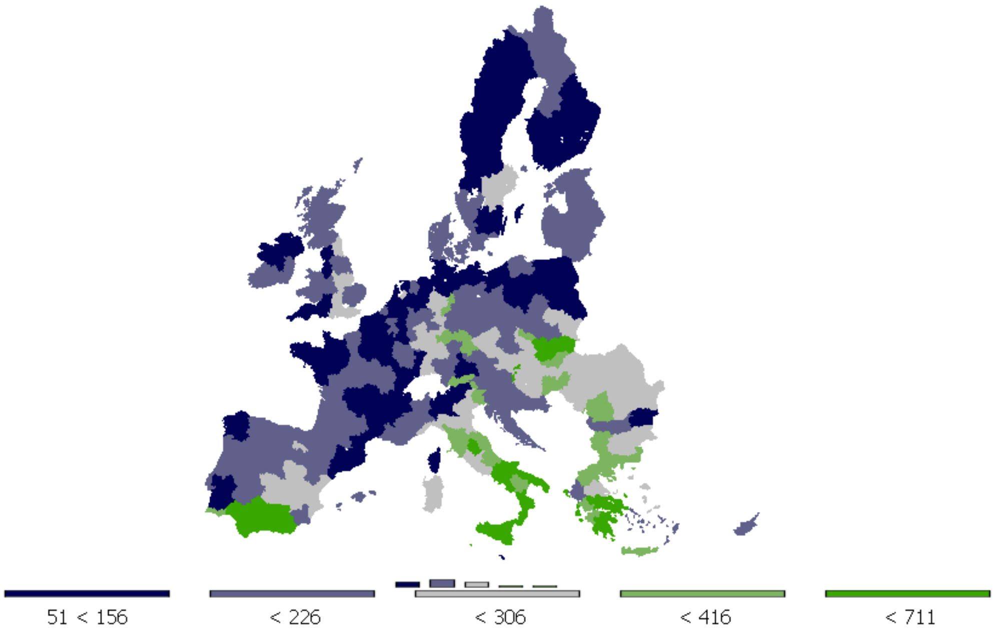
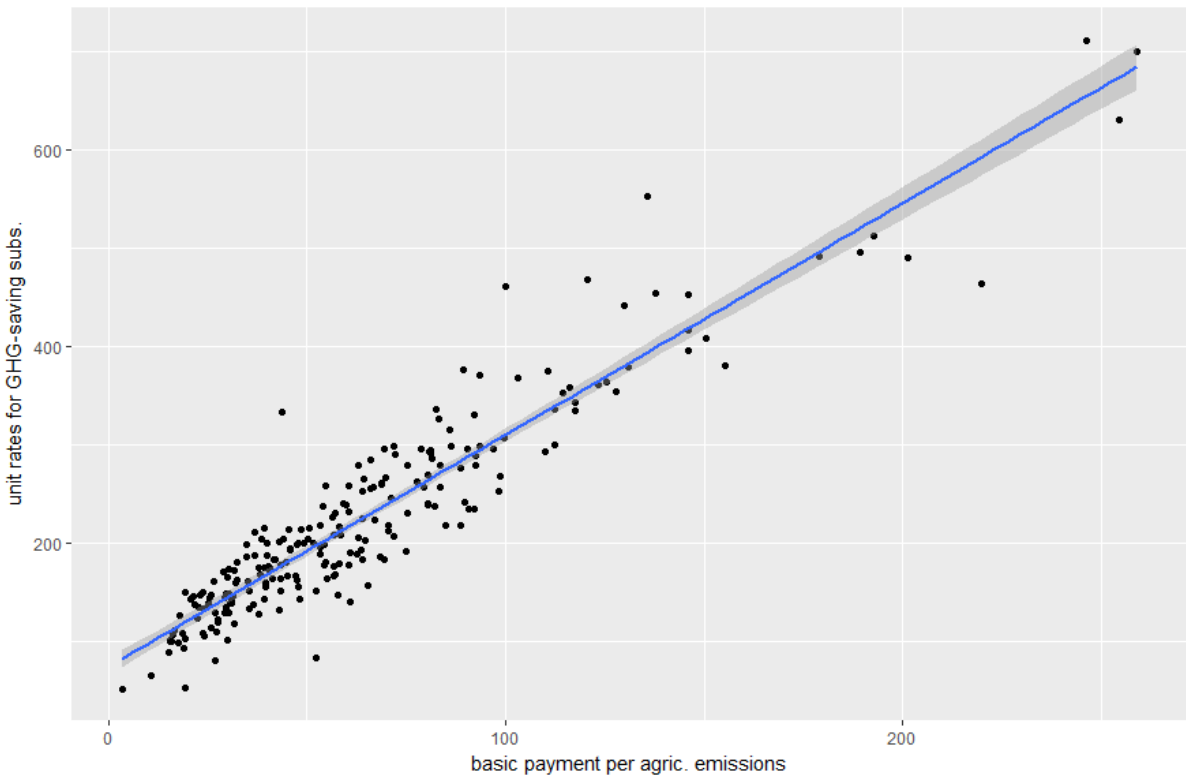


Figure 4: Budget-neutral unit subsidies vs. basic payment per agricultural non-CO_2 emissions in the baseline, all CAPRI regional units

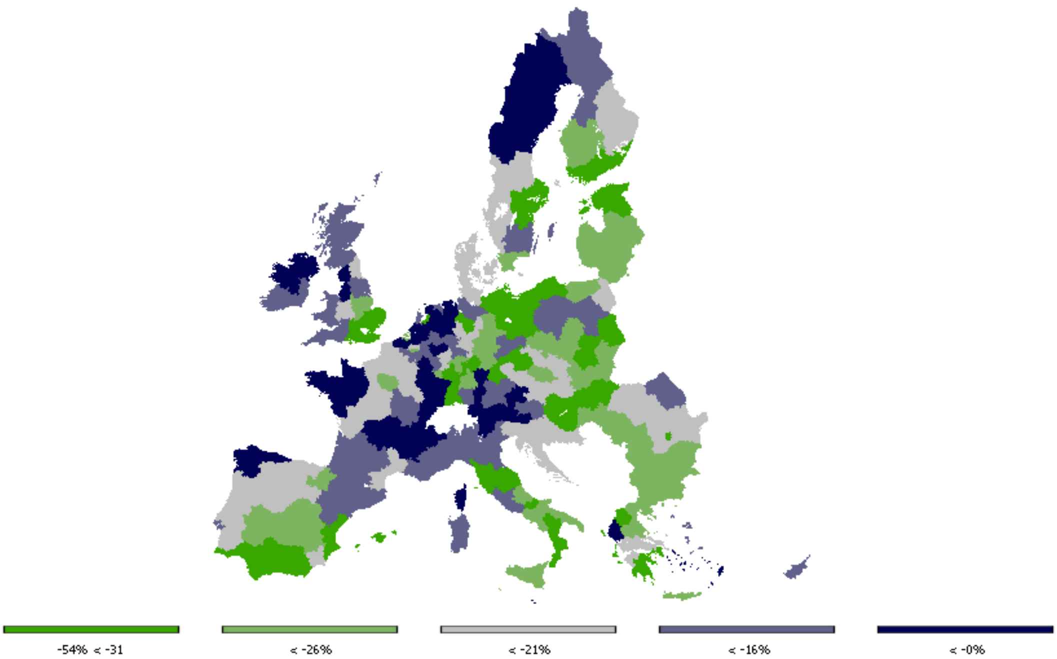


3.2 Economic and environmental impacts on EU agriculture

In the following scenario analysis we remove the basic direct payment in all EU regions and activate a non-CO_2 emission-saving subsidy with the estimated budget-neutral unit rates. By activating the market module of CAPRI, the price feedback from the agricultural markets is factored in the scenario results presented below.

As a direct effect of moving towards subsidized budget-neutral emission savings, agricultural non-CO_2 emissions (measured as Global Warming Potential, GWP), would decrease by -21% at the EU aggregated level, compared to the baseline. Regional differences are substantial, with emission decreases ranging from -8% to -54% Nevertheless, regions with higher unit subsidy rates do not correlate with the regions reducing the most emissions (Figure 5). This suggests that in many regions the rate of the emission-saving subsidy is over the tipping point of the emission reduction potential: with the available technological and production-reducing options for mitigation farmers cannot efficiently reduce their emissions further. In section 3.3 we further elaborate on the inefficiencies that the budget-neutrality condition introduces in our calculations, comparing the results to an alternative scenario with uniform EU-wide subsidy rates.

Figure 5: Agricultural non-CO_2 emissions, relative change to baseline (2030)



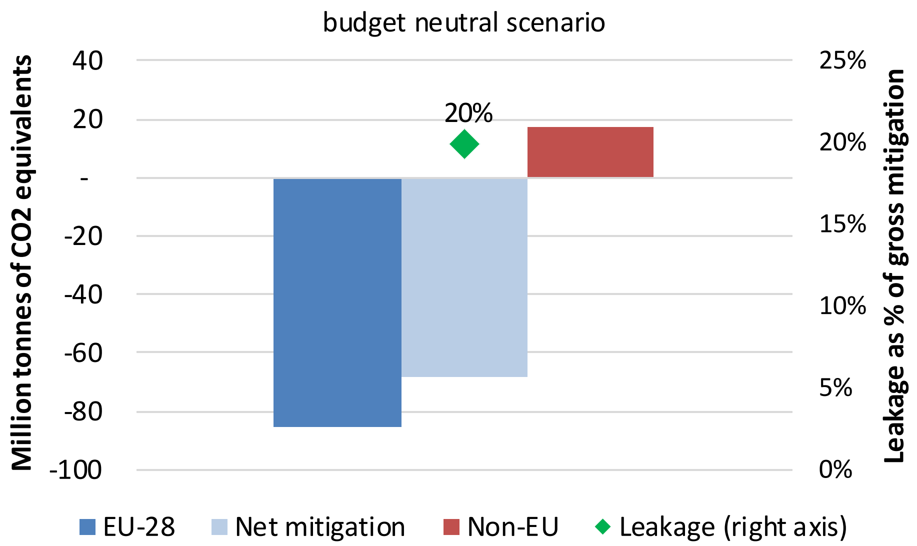
Both the production effect and the adoption of new technologies for decreasing emissions are substantial. Almost two-thirds (64%) of the emission savings are due to the production effect, i.e. decreases and shifts in production, while the remaining 36% is achieved by adopting technological mitigation options (Figure 8). Consequently, the EU supply of all major agricultural products decreases. In terms of land use changes, total utilized agricultural area decreases by -5.6% (with fodder activities suffering the biggest decrease), leading to a substantial increase in set aside areas and fallow land (+33%). With regard to animal activities, the ruminant meat sector is the most affected (-12% decrease in herd size), but the pig production is also negatively affected (-2.5% decrease in pig meat supply, Table 2).

Table 2: Relative changes in supply and producer prices for the EU28 (%-change compared to baseline

	Net production	Producer Price
Cereals	-7.4%	6.2%
Oilseeds	-5.3%	6.5%
Fodder	-10.4%	-37.7%
Total meat	-3.4%	13.1%
- Beef	8.8%	29.5%
- Sheep and goat	10.7%	20.4%
- Pork	-2.5%	9.3%
- Poultry	-0.3%	5.3%
Raw milk	-1.8%	10.3%

In line with previous literature, the unilateral mitigation effort of the EU leads to emission leakage effects, fuelled by the relative emission efficiency of the EU agricultural sector (see e.g. Barreiro-Hurle et al. 2016; Fellmann et al. 2018; Himics et al. 2018). Emission savings of the EU are partially offset by increasing emissions in other parts of the world (Figure 6), mainly in the EU's main trading partners. The limited leakage effect (20%) is due to the relatively protected EU agricultural markets for those commodities where the EU is in a strong net importer position (e.g. beef). Our scenario does not include any change (liberalization) in trade policies, and therefore the tariff and other quantitative (e.g. Tariff Rate Quota) restrictions limit the expansion of EU imports, even if EU agricultural supply decreases significantly. EU trade protection therefore contributes to the limitation of emission leakage and hence to the more than 1% decrease in global non-CO_2 emissions from agriculture. At the downside of the limited expansion possibilities for EU imports, the price impacts on the EU domestic markets are pronounced, decreasing also consumer welfare.

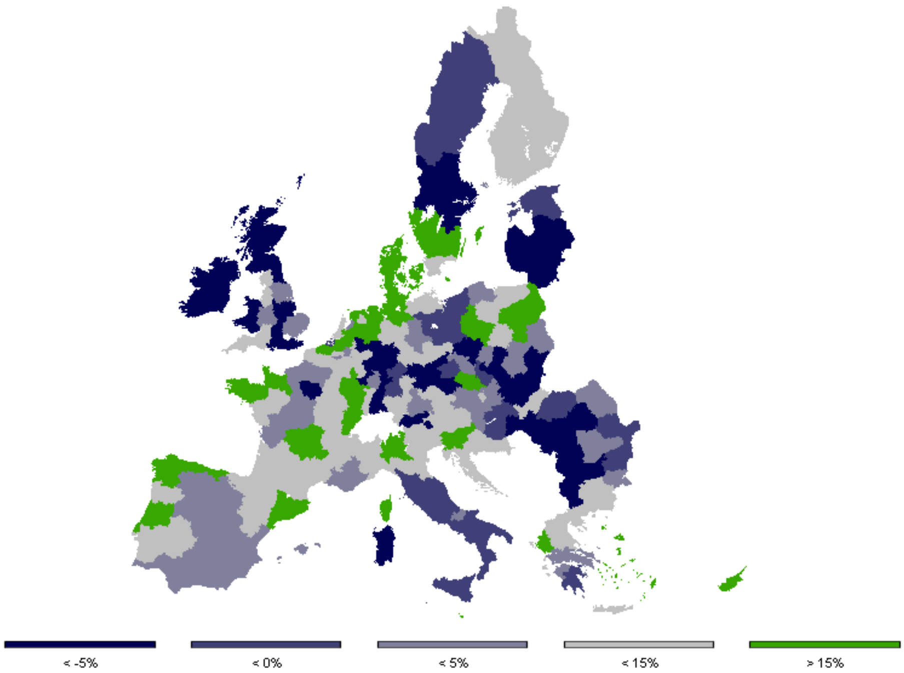
Figure 6: Emission leakage as the percentage of gross mitigation



The GHG-saving subsidy turns out to over-compensate farmers with a positive impact on farmers' income at the aggregated EU level (+5.7%). Nevertheless, a substantial re-allocation of agricultural income can be observed within EU regions and within agricultural sectors, with both winners and losers of the changing subsidy scheme (Figure 7). Some regions take advantage of the general, EU-wide price increase, and the increased production efficiency (e.g. milk yields) induced by the adoption of technological mitigation options. In other regions the negative quantity effect dominates and triggers substantial income losses for the agricultural sector.

Due to the relatively inelastic demand for food, and to the trade protection of EU agri-food markets, decreasing agricultural supply leads to a general increase in producer prices. Although consumer price margins for food products are generally large, the price increase still triggers a -2.5% decrease in consumer surplus. As agricultural income does not decrease, and taxpayers' costs of EU agricultural policies do not change due to the budget-neutrality condition, consumers take over the negative welfare implications of the scenario in our partial equilibrium framework[2] and pay the price of the simulated increased climate action in agriculture.

Figure 7: Agricultural income (marginal gross value added), changes relative to baseline (2030)



3.3 Implications of the budget-neutrality condition

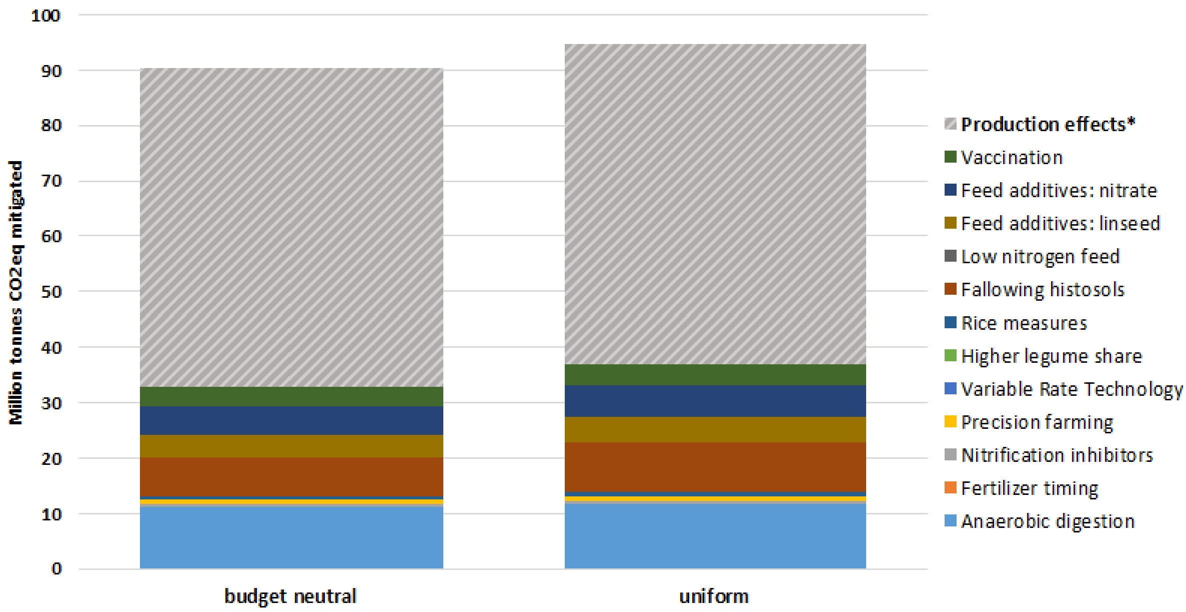
The subsidy rates in section 3.1 are calculated by imposing the budget-neutrality condition. Farmers in a given region are incentivized to reduce emissions to such an extent, that the total payments to farmers for emission-savings is equal to the current basic payment envelope allocated to the region. The subsidy rates are therefore not optimal from a pure emission reduction point of view. To illustrate this issue, we present some selected results of an EU-wide uniform emission saving subsidy scenario. The alternative scenario includes the same removal of basic payments as in the budget-neutral case, but the GHG-saving subsidy rates are set uniformly to the EU average subsidy rate of 181.3 EUR/t of CO_2 eq.

Simulation results indicate that the reduction in agricultural emissions is larger in the case of the uniform subsidy than in the budget-neutral case (-22% vs. -21% at the EU average), with more

[2] The partial equilibrium framework of CAPRI is not able to capture the changes in factor incomes. We assume zero transaction costs for the implementation and monitoring of the emission saving subsidy in the scenario, which is treated as a lump sum transfer from tax payers to farmers.

emissions being reduced due to the application of the technological mitigation options (Figure 8), while the required budget is -3% smaller. The uniform rate is therefore more efficient in reducing emissions in terms of the necessary budget. The budget-neutrality condition also introduces inefficiencies with respect to agricultural income, as the increase in agricultural income in the uniform subsidy scenario is also slightly higher (+6.6%). Thus it seems possible to design more efficient policy options (at least at the EU aggregated level) by moving away from the current status quo of the regional pattern of CAP basic payments when aiming at GHG emissions reduction in the EU´s agricultural sector.

Figure 8: Production and technology effect using budget-neutral or uniform subsidy rates



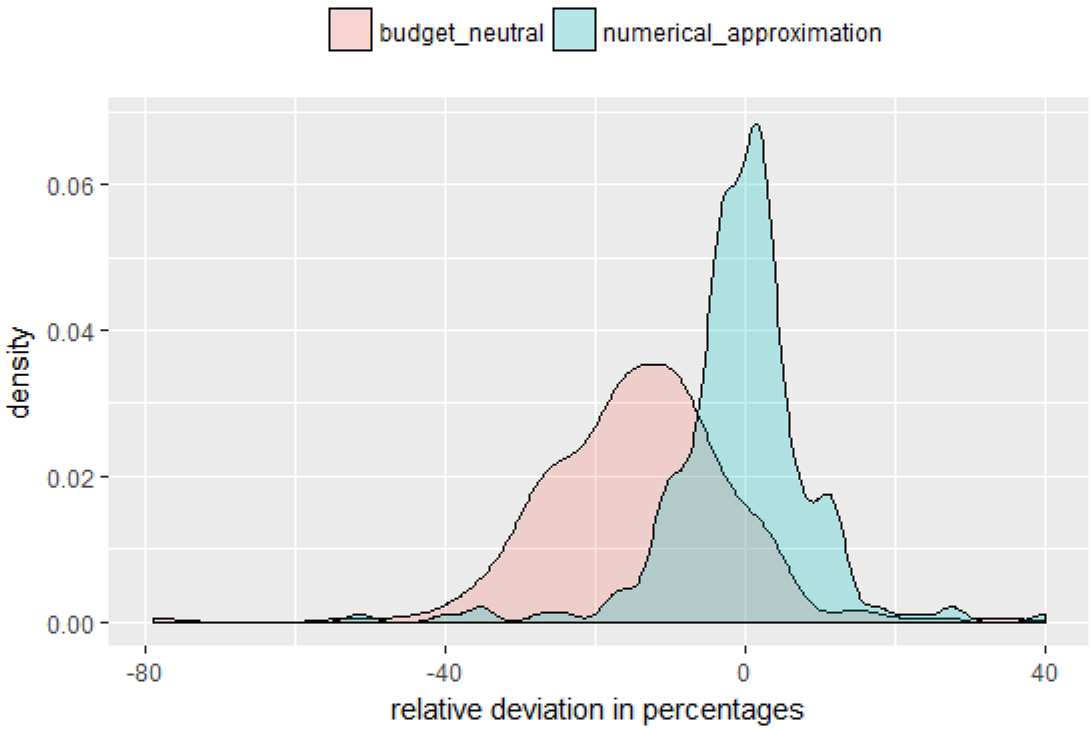
*The mitigation effects linked to genetic improvement measures cannot be analysed in isolation and are included in the mitigation achieved by changes in production

3.4 Implications of the fix price assumption

Turning towards the limitations of our approach, it is unclear how much bias we introduce in the estimation of the budget-neutral subsidy rates by calculating them under the fix-producer price assumption during the numerical approximation. In theory, the introduction of an emission saving subsidy for farmers triggers both a decrease in agricultural supply (production effect) and changes in production systems towards more emission efficient farming practices (technology effect). If the production effects dominate this can lead to significant price increases. Assuming higher prices, ceteris paribus, the necessary incentive to cut agricultural emissions to the same degree also needs to increase, leading to higher unit subsidy rates. More emission efficient technologies also come at a significant adoption cost, pointing also to the direction of increasing producer prices and thus higher unit subsidy rates. Overall, it seems likely that our budget-neutral unit subsidy rates calculated under the fix price assumption are somewhat underestimated.

The budget-neutrality condition is only imposed during the numerical approximation for deriving the subsidy rates per tonnes of CO_2 equivalents. On the other hand, nothing guarantees budget neutrality in the scenario runs. In fact, the positive price feedback from the market implies that farmers in general take up somewhat less emission-saving subsidies than the current basic payment envelopes. The deviation from the budget-neutrality condition is region specific, but clearly follows the explained tendency. While the deviations during the numerical approximation are between the error range (-1.8% on EU average), regional deviations increase substantially during the scenario run, moving toward smaller budgets utilized by farmers for emission savings (Figure 9).

Figure 9: Relative deviations from the budget neutrality condition during the numerical approximation and during the simulation of the budget-neutral policy shift



The increasing negative deviations from budget neutrality in the simulation results indicate that the majority of the unit subsidy rates are underestimated due to the fix price assumption of the numerical approximation method, and therefore a larger emission-saving subsidy might be paid for farmers without increasing the necessary financial resources.

4 Conclusions

For this paper we conduct a simulation experiment to quantitatively assess the impact of a policy that removes the current basic CAP direct payments of Pillar 1 and instead provides farmers a GHG-saving subsidy in a budget-neutral manner. In the simulation we aim at a fully budget neutral shift in all EU NUTS2 regions, i.e. the GHG-saving subsidy provided to farmers requires exactly the same budget as the current basic payment in the given region. This strong budget-neutrality condition is motivated by the current discussion on the future CAP post 2020, pointing in the direction of a shrinking, or at least non-increasing future CAP budget. Results presented include simulated impacts on commodity balances, producer prices, trade, income and welfare implications, and changes in agricultural non-CO_2 GHG emissions in the EU and the rest of the world.

The estimated unit subsidy rates for a regional budget-neutral emission reduction subsidy in the EU show large regional variation in the range of 51 to 711 EUR/t of CO_2 equivalents, with a median value of 198.5 EUR/t of CO_2 eq. The regional differences can be explained by a combination of both

(a) differences in the structure of the current CAP payments (in particular the weight of basic payments in total direct payments) and (b) the production structure that defines the flexibility of the regions to reduce agricultural non-CO_2 emissions. Non-surprisingly, regions with larger basic payments relative to total emissions farmers need a larger unit rate to arrive at a budget-neutral shift to emission saving subsidies.

The simulated shift towards subsidized budget-neutral emission savings leads to a decrease in EU agricultural non-CO_2 emissions by -21% compared to the baseline in 2030. Regional differences are substantial, but regions with higher unit subsidy rates do not correlate with the regions reducing the most emissions. This suggests that in many regions the available technological and production-reducing options for mitigation are not sufficient for an efficient further emissions reduction. At aggregated EU level, 64% of the emission reduction is achieved by decreases and shifts in production, whereas 36% are due to the adoption of the technological mitigation options. As a consequence, EU supply decreases significantly for almost all major agricultural products, most pronounced for beef meat as well as sheep and goat meat activities.

Assuming a relatively emission efficient EU agriculture, scenario results show that emission savings in EU agriculture are partially offset globally due to increasing agricultural production in less emission efficient trading partners of the EU. Although the simulated emission leakage effect is limited (20%) it reveals that a more ambitious contribution of agriculture to combat global warming requires discussing future European agricultural policy in a wider context: both geographically and with regard to the political landscape. Coordination between agricultural, environmental and trade policies (being international trade the transmitter of leakage effects) seems to be a challenge for the CAP discussion that needs to be taken into account when streamlining the delivery system of agricultural subsidies.

The budget-neutral subsidy rates are certainly not optimal from a pure emission reduction point of view, by design. We make this point clear with an alternative scenario that includes the same removal of basic payments but the GHG-saving subsidy rates are set uniformly to the EU average subsidy rate, without aiming budget neutrality. The uniform subsidy leads to a larger emission decrease (-22%) than the budget-neutral subsidy (-21%), with a 3% lower budget. This indicates that more efficient policy options might be designed for GHG emissions reduction in the EU´s agricultural sector, by moving away from the current regional pattern of CAP basic payments.

The subsidy, as implemented in our scenarios, favours those farmers who can reduce their current emissions the most, without taking into account the relative emission efficiency of current[3] farming practices throughout the EU. It can be argued that this scheme penalizes farmers who had already invested in emission-efficient technologies, and therefore require above average financial incentives to achieve further GHG reduction. Policies targeting technological development explicitly might lead to dominating technology effects and lower production effects, without the significant land abandonment impacts indicated in our simulation results. In CAPRI the relative GHG-efficiency of current farming practices is only represented at an aggregated level, with differences in the production technologies of regional representative farms, limiting therefore the scope of discussion of this issue here.

[3] The comparative static analysis has been performed in year 2030, based on a projection of agricultural farming practices according to a business-as-usual baseline.

While there is still some scepticism regarding the implementation and monitoring costs of the subsidy system described in our scenario, we believe that our results allow assessing the potential of the CAP in terms of increasing its contribution to GHG emission reduction efforts and wider environmental benefits. We also conclude that taking the current status quo of the regional pattern of CAP basic payments as benchmark for direct agricultural GHG emission-reduction policy options would be suboptimal in terms of budgetary efficiency.

Disclaimer

The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

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