Greenhouse Gas Emission Trading in European agriculture: a comparison of different policy implementation options in year 2020

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(preliminary draft)

Abstract

In this paper the agricultural sector model CAPRI is expanded to cover non-CO2 greenhouse gas emissions from agricultural sources in Europe and policy instruments for their reduction. A stylised spatial trade model for emission permits is methodologically described and applied to the assessment of three potential policy alternatives for enforcing emission reductions from European agriculture: the EU 'effort sharing agreement', an EU-wide emission trading scheme between regions inside each Member State and, finally, an EU-wide emission trading scheme between all European regions. This paper builds in the experience accumulated by Pérez Domínguez et al. (2010) and provides a through review of the underlying methodology, a expansion of emission sources and a larger projection line (year 2020). Results shows the importance of selecting an adequate combination of instruments of emission abatement for the design of efficient emission reduction policies.

Keywords: Copenhagen agreement, effort sharing agreement, agricultural policy, economic modelling, tradable emission permits

1. Introduction

The expiration in 2013 of the major multilateral agreement on the reduction of anthropogenic emissions within a specific timeframe, the Kyoto Protocol, introduced an additional need for negotiations. In may 2009, the United Nations Climate Change Conference (UNFCCC) took place in Copenhagen. There, climate change was recognized as *"one of the greatest challenges of the present day"* and a concrete proposal for further reduction of greenhouse gases (GHG) was included. The Copenhagen Accord was drafted in December 2009 and signed by 138 countries in January 2010. Even if not legally binding, this document includes for the first time the signature of the 4 main emitters of GHG in the world (US, China, Russia and the EU) and establishes the reference for a future multilateral agreement.

What respects the EU, an internal commitment was achieved to "unconditionally" implement an EU-wide binding legislation on further reduction of emissions by -20% until 2020, even without a satisfactory deal in Copenhagen. Moreover, in December 2009 the European Union revised its carbon allowances system designed for the post-Kyoto period (after 2013), the so-called EU 'Emissions Trading Scheme' (ETSA). This new stage of the system aims at further reducing GHG emitted in Europe in a binding way and at showing the commitments the EU had already done before the Copenhagen meeting.

Addressing climate change from a multi-gas strategy perspective (i.e. including reduction commitments for non-CO2 emissions) is becoming a key issue in the ongoing climate negotiations. This raises the issue of the role of land use and land use change (LULUCF). Actually, the agricultural sector is a large contributor of two relevant non-CO2 greenhouse gas emissions: methane (CH4), mainly from ruminants, and nitrous oxide (N2O) from fertilizer application and management. In figures, agriculture accounted for estimated emissions of 6.1 GtCO2-eq/yr in 2005 (12% of total global anthropogenic GHG). These can be split in 3.3 GtCO2-eq/yr of CH4 (50% of overall CH4 emissions) and 2.8 GtCO2-eq/yr of N2O (60% of overall N2O emissions) (Smith et al. 2007). The large contribution of agriculture to non-CO2 emissions and its rapid integration with energy markets, as supplier of renewable energy, hints at an important sector for CO2 mitigation.

Combining some of the issues raised above, this paper aims at a quantitative assessment of a potential extension of the ETS to the agricultural sector, including emission reduction efforts in line with the Copenhagen commitments. With this purpose, marginal abatement costs for agricultural production systems and trade of CO2 emission permits in the EU are calculated based on the CAPRI model (see Britz & Witzke 2008), building on the methodology developed by Pérez Domínguez et al. (2010).

The paper is organized as follows. Section 2 presents the module introduced in CAPRI to allow for emission trading. Section 3 presents the main elements of the 2020 baseline and the definition of the scenario with a focus on relevant emissions from European agriculture, following by section 4 presenting major results. Section 5 summarizes and draws some conclusions.

2. Methodological description

The spatial equilibrium model described in here follows the general framework developed by Takayama and Judge (1971) and it is specifically tailored to represent regional (spatial) trade of non-CO2 emission permits. In particular, the model is based on the following sets of tradable permits and regions:

• G types of tradable permits related to a specific emission inventory from agriculture: G = {methane from enteric fermentation, nitrous oxide from manure management, etc.}
• R European regions at Nuts 2 level: R = {Brandenburg, Andalucía, etc.}

Consider a set of i, j = 1,2...R regions that produce g = 1...G emission inventories. In order to ease the notation, we will only consider in our exposition a single emission inventory, which is a weighted aggregation of all the others (i.e. in terms of global warming equivalents). The definitions and notation to be employed are summarized as follows:

Let

W	denote net social payoff (Takayama and Judge, 1964)
Q{p_i}	denote regional permit demand quantities, i=1,2,.., n
P{di}	denote the regional demand prices, i=1,2,.., n

The p_i are depending on linear permit demand functions of the quantities q_i, such that:

$$p_i = \alpha_i - \beta_i * q_i \qquad (1)$$

B{b_{ik}}	denote the flow of permits **b**ought into region i from the regional aggregate k, k={k_1,k_2} depending if trade if permit imports are coming from regions within a Member State of i ($i \in k_1$)or from regions in other Member States outside ($i \in k_2$).
S{s_i}	denote the flow of permits **s**old by region i to the regional aggregate k, k={k_1,k_2} depending if trade if permit exports are going to regions within a Member State of i ($i \in k_1$}or to regions in other Member States ($i \in k1_2$).
D{d_i}	denote the amount of permits **d**istributed to region i, which are defined by the emission reduction objective simulated
H{h_k}	denote transaction costs per origin k, k={k_1,k_2} and k_2>k_1 since transaction costs are higher if trade takes place with regions in different Member States

To maximize:

$$W = \int_{\bar{d}_i}^{q_i} p_i q_i \xi_i - \sum_{ik} b_{ik} * h_k \qquad (2)$$

subject to

$$\sum_i [s_{ik}] = \sum_i [b_{ik}] \qquad (3)$$

$$q_i = d_i + \sum_k [b_{ik}] - \sum_k [s_{ik}] \quad (4)$$

$$q_i, p_i, b_i, s_i \geq 0 \quad (5)$$

Equation (2) calculates the net welfare gain/loss, which is equal to the value of the permits sold/bought between the initial distribution and the final demanded quantity, minus the transaction costs incurred in trade (in the case of buying permits).
Equation (3) implies that imports and exports within a MS have to match ($i \in k1$), as well as imports and exports from and to other MS regions ($i \in k2$).
Equation (4) implies that regional permit demand is equal to the initial distribution of permits plus the amount of permits bought minus the permits sold.
According to the spatial arbitrage condition, the equilibrium conditions can be interpreted as follows. Permit prices between any two regions can differ at most by the transaction costs and are equal to transaction costs for pairs of regions where trade take place, so that $p_i - p_j = h_{k1}$ if $i,j \in k1$ and $p_i - p_j = h_{k2}$ if $i, j \in k2$

Linear permit demand functions (see equation (1)) must be parameterized based on information on marginal emission abatement costs per region from the CAPRI supply models to ensure a consistent integration in the overall framework. Let

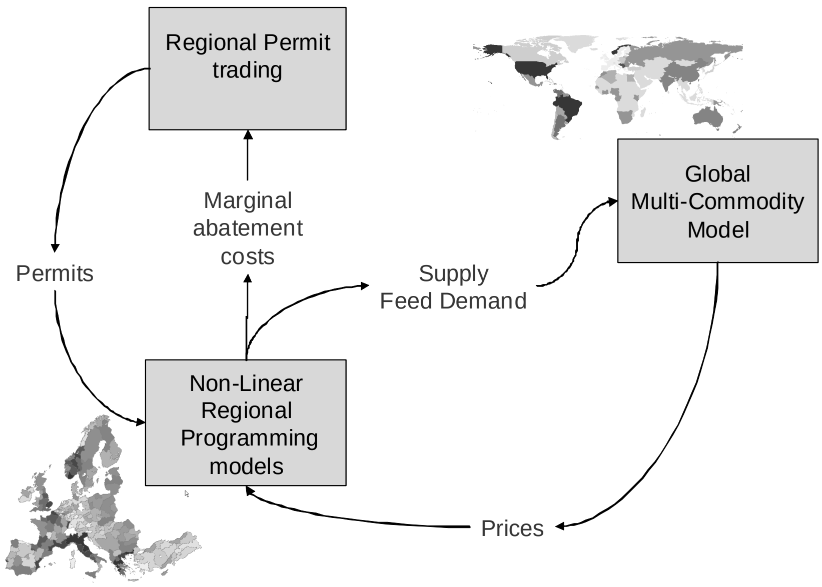
- $E\{e_{is}\}$ denote regional **e**missions, as calculated by the CAPRI supply model in step s, s={1,2,…,S}
- $C\{c_{is}\}$ denote regional **c**osts of emission abatement in step s

$$\begin{aligned} \beta_i &= \left[\left(c_{i,s-2} - c_{i,s-1} \right) / \left(e_{i,s-2} - e_{i,s-1} \right) \right] \\ \alpha_i &= c_{i,s-1} - \beta_i * e_{i,s-1} \end{aligned} \quad (6)$$

Equation (6) recalculates within an iterative process the parameters of the linear regional permit demand functions, such as to meet the marginal abatement costs achieved by the regional supply models in CAPRI. The first line estimates the slope of implicit marginal abatement function for each region from the last two iterations' marginal abatement costs and emissions, and the second line chooses an constant term such that the marginal costs of the last iteration are recovered at the last iteration's emissions and the estimated slope.
The process is graphically depicted in figure 1. Starting with a given permit distribution based on a % reduction of historical emissions, the regional supply models are solved, generating dual values related to the maximum permissible emissions. This has an effect on production since, for instance, high emitting activities (e.g. intensive cattle production in the Netherlands) are expected to experience a

higher loss in income than low emitting activities (e.g. rain-fed cereal production in south Portugal). These changes in supply and feed demand quantities enter the international market and trade model, where price adjustments for agricultural outputs are needed to allow for market clearing. At this stage, the permission trade module re-distributes permits from regions with low marginal abatement costs to other regions with high marginal abatement costs, allowing for welfare gains between the regions involved in the trade. According to the distributed emission permits, a new maximum of emissions permitted enter the supply models in the next solve, generating a new vector of regional marginal abatement costs which are also depending on the updated output price. Again, the market model is solved at updated supply and feed demand quantities. Market clearing of agricultural products and of regional emission permits iterate until convergence is achieved, i.e. changes between iterations for both quantities and prices of agricultural products and emissions permits fall beyond pre-defined relative thresholds of 0.05%. The solution characterizes a simultaneous equilibrium in EU agricultural permit markets and regional as well as global primary and secondary agricultural product markets.

Figure 1. CAPRI model flow with explicit consideration of regional emission permit trading



Source: Pérez Domínguez et al. (2010)

3. Scenario Construction

The base year scenario is a three-year average around 2004 and establishes the reference period for GHG emission reduction. Activity data used for the calculation of GHG emissions come mostly from Eurostat after some necessary manipulations in order to achieve completeness and consistency (see CAPREG database in Britz et al. 2008). Emission coefficients at regional level are calculated by following the latest guidelines published by the Intergovernmental Panel on Climate Change (IPCC, 2006). Here the circular flow of supply/demand of nutrients by different agricultural activities is a corner stone.

The 2020 baseline covers the latest changes in the CAP, including the so-called "Health Check" reform, i.e. removal of remaining coupled supports, with the exemption of suckler cows and sheep & goats, and abolishment of dairy quotas. It shows relative high prices in international and EU markets for major products, which in parts are motivated by the implementation of bio-fuel mandates in major world regions. It does not assume further multi-lateral trade liberalization steps. Major pillar II instruments (LFA; agri-environmental payments, N2K) are integrated in a rather stylised way as subsidies to land. When paid to arable crops, they are modulated such as to favour extensive production techniques.

The emission reduction target for agriculture modelled covers all EU27 MS and is projected to be implemented in the year 2020 (end of the first commitment period of the Kyoto Protocol) on top of the current legislation. Three policy implementation options have been simulated:

1) A **regional homogeneous emission standard of -20%** with respect to the base year 2004. The reduction is equal in relative terms in all European regions, and thus independent from differences in abatement costs. The base year emissions in CAPRI are calculated based on the emission coefficients published by the Intergovernmental Panel on Climate Change (IPCC), the nutrient content per activity and the projections responding to the most-likely development of the international agricultural markets (see also table 1).
2) **Unrestricted emission trading**. In this scenario, a 20% emission reduction target with respect to 2004 is enforced in year 2020 for the aggregate of all EU27 regions while trade across all regions is allowed. The original permit distribution is based on the regional emissions in the base year minus 20%.
3) **Restricted emission trading**. In this scenario, a 20% emission reduction target with respect to 2004 is enforced in year 2020 for all regions within the EU27 but trade is only allowed within countries. The idea is to mimic existing trading schemes in the EU (e.g. different trading schemes of milk quotas depending on the MS). The original permit distribution remains the same as in the previous scenarios.

Table 1. Scenario characteristics

Scenario name	Policy instrument	Emission reduction
Base year scenario (year 2004)	*(not applicable)*	*(not applicable)*
Baseline scenario (year 2020)	*(not applicable)*	-6.8% GHG emission reduction w.r.t. EU27 average emissions in 2004 (trend-driven)
Emission standard scenario (year 2020)	Emission standard with a regionally homogeneous cap (no trade in emission rights)	-20% GHG emission reduction commitment w.r.t. EU27 average emissions in year 2004
Emission trading scheme for agriculture - unrestricted (year 2020)	Trade in emission rights between all EU regions and MS	
Emission trading scheme for agriculture - restricted (year 2020)	Trade in emission rights between regions within a MS (and not across MS)	

The results provided by this emission trading model are linked to some general model assumptions. First of all, full rational behaviour of regional agricultural producers is assumed in CAPRI. Whereas agricultural profit in each region is maximized subject to economic and agronomic constraints, supply, demand and trade are balanced by market clearing prices in open economies covering the globe linked by the Armington assumption. Secondly, the calculation of GHG emission indicators root in the basic economic behaviour of the model: (a) optimal cropping patterns, animal herds and feeding at regional level, (b) a balanced nitrogen flow model based on explicit energy requirements and deliveries per agricultural activity, distinguishing between organic and anorganic deliveries, and (c) a set of emission factors derived from the literature (IPCC, 2006). Total emissions per MS are, therefore, the result of these three interacting elements. Thirdly, it is important to stress that permit prices are equal to the shadow values of the emission constraints included in the regional supply models. Since no additional information on emission prices for the proposed EU trading scheme of agricultural emissions was available, no additional calibration efforts were done here (contrary to e.g. explicit calibration of land prices or milk quotas in certain MS were information was available). Since no reliable information on transaction costs is currently available, no transaction costs have been considered in this analysis (see previous analysis: Pérez Domínguez 2006; Pérez Domínguez et al. 2009; Perez Domínguez et. al 2010).

4. Results

Table 2 presents the development of emissions of individual gases and CO2 equivalent for all EU Member States from the 2003-2005 base period to the 2020 baseline. With the exemption of Malta, Spain and the Netherlands, a reduction in total emissions can be observed in all countries. The current baseline implies a somewhat higher reduction in the new MS compared to EU15. However, given that GHG emission in EU15 in the base year are almost five times higher then in the new MS, the reduction in EU15 from 2004 to 2020 is more significant in absolute terms.

Table 2. Evolution of aggregated non-CO2emissions per Member State (2004 – 2020)

	Base Year (2003-2005)			Baseline (2020)		
	Methane [MMt CO2eq]	Nitrous Oxide [MMt CO2eq]	CO2 equivalents [MMt CO2eq]	Methane [% to BAS]	Nitrous Oxide [% to BAS]	Total [% to BAS]
Austria	4.3	3.9	8.2	-15.9	0.0	-8.4
Belgium-Lux.	5.5	5.6	11.2	-4.9	0.6	-2.1
Denmark	5.3	6.9	12.2	-21.3	-11.6	-15.8
Finland	2.0	7.7	9.7	-14.7	-3.9	-6.2
France	37.5	45.3	82.8	-14.5	4.5	-4.1
Germany	32.2	34.3	66.6	-21.1	4.4	-8.0
Greece	3.3	3.3	6.5	-7.3	-15.1	-11.2
Ireland	11.8	11.5	23.3	-6.3	6.3	-0.1
Italy	17.7	17.0	34.8	-6.3	-5.0	-5.6
Netherlands	9.0	10.6	19.6	3.3	-2.7	0.0
Portugal	3.6	3.2	6.8	-13.8	-9.6	-11.9
Spain	18.7	20.8	39.5	0.6	7.5	4.2
Sweden	3.8	6.4	10.2	-31.8	-3.4	-14.0
United Kingdom	22.0	39.4	61.4	-12.1	-4.7	-7.3
EU15	176.8	215.9	392.8	-11.7	0.4	-5.1
Cyprus	0.3	0.2	0.5	-1.3	-1.3	-1.4
Czech Republic	2.9	4.4	7.3	-53.7	-8.0	-25.9
Estonia	0.6	0.7	1.2	-47.8	6.8	-17.7
Hungary	2.0	5.8	7.8	-42.2	2.1	-9.5
Latvia	0.8	1.5	2.2	-42.1	-2.1	-16.0
Lithuania	1.8	3.1	4.8	-34.9	5.9	-9.1
Malta	0.0	0.0	0.1	5.3	14.3	8.6
Poland	11.2	21.8	33.1	-27.5	-2.5	-11.0
Slovac Republic	1.1	1.5	2.6	-49.1	-8.4	-25.4
Slovenia	0.9	0.9	1.8	-18.6	-5.6	-12.2
10 New MS	21.5	39.9	61.5	-34.3	-1.9	-13.3
Bulgaria	2.2	2.8	5.0	-34.2	-12.0	-21.8
Romania	8.7	8.1	16.8	-30.2	-9.6	-20.2
Bulgaria/Romania	10.9	10.9	21.8	-31.0	-10.2	-20.6
EU27	209.3	266.8	476.1	-15.0	-0.4	-6.8

Table 2 also reveals that the baseline shows for Czech and Slovak Republic as well as for Bulgaria and Romania GHG emissions falling below 80% of the base year. These MS would be clearly benefiting in a permit trading scheme, as their abatement costs in average of the sector would be zero due to a permit overhang after limiting their emissions by a 20% cut (in other words, they would be free to decide if increase their emissions at no additional cost or sell their permits to other MS). This also shows that a emission reduction commitment based on historical emissions must not be necessarily binding for all players in the system, what can result in a lower average emission reduction effort that initially foreseen by policy makers (i.e. this is the so-called “hot air”[1]).

As seen from Table 3, the reduction at EU level is mostly based on emission linked to ruminants (methane) and manure management. They can therefore mostly be attributed to the reduced policy incentives for beef cattle and sheep & goat after the conversion of coupled supports for beef production into (mainly) decoupled payments, and the reform in the dairy market. The adjustments in emissions are generally larger in the new MS compared to EU15. Crop yields continue to grow moderately, provoking an increase in emission linked to crop residues, and to lesser extent, to application mineral nitrogenous fertilizers. The latter can be attributed to a more efficient use of both organic and mineral fertilizers.

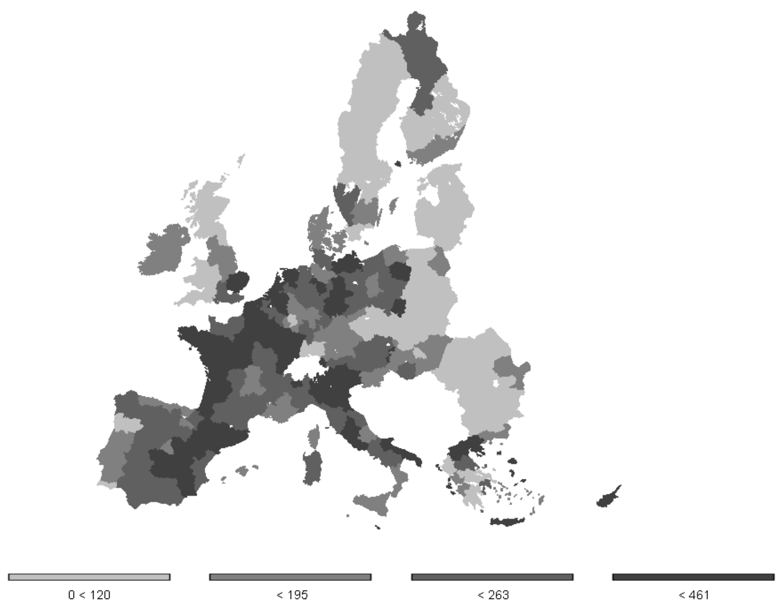
[1] Some literature was written related to the inclusion of Russia and US in the Kyoto Protocol (Klepper and Peterson, 2005). Similar problems can be observed in other policies, such as the well-known “water in the tariffs” affecting trade liberalization policies.

Table 3. Evolution of specific emission sources for the EU27 (2004 – 2020)

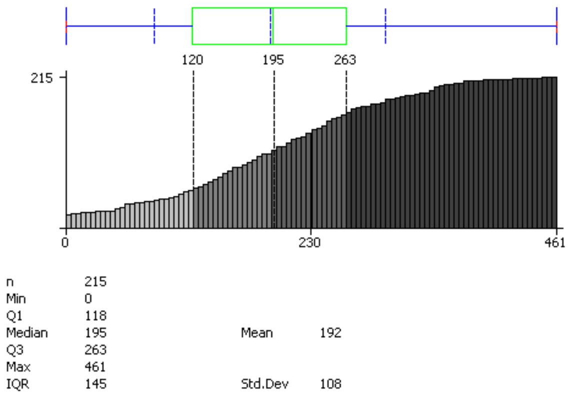
	Base Year (2003-2005)				Baseline (2020)			
	EU15 [MMt CO2eq]	EU10 [MMt CO2eq]	BUR [MMt CO2eq]	EU27 [MMt CO2eq]	EU15 [% to BAS]	EU10 [% to BAS]	BUR [% to BAS]	EU27 [% to BAS]
Methane emissions from enteric fermentation (IPCC)	145.3	18.6	10.0	173.8	-13.2	-37.2	-30.8	-16.8
Methane emissions from manure management (IPCC)	31.5	3.0	0.9	35.4	-4.7	-16.0	-33.4	-6.4
Methane emissions	176.8	21.5	10.9	209.3	-11.7	-34.3	-31.0	-15.0
Direct nitrous oxide emissions stemming from manure managment and application except grazings (IPCC)	55.2	10.7	2.9	68.8	-2.5	-8.8	-13.7	-3.9
Direct nitrous oxide emissions stemming from manure management (only housing and storage) (IPCC)	*33.1*	*7.0*	*2.1*	*42.2*	*-3.2*	*-9.1*	*-13.7*	*-4.7*
Direct nitrous oxide emissions stemming from manure application on soils except grazings (IPCC)	*22.2*	*3.6*	*0.8*	*26.6*	*-1.3*	*-8.3*	*-13.3*	*-2.6*
Direct nitrous oxide emissions from anorganic fertilizer application (IPCC)	55.5	12.2	2.4	70.1	2.6	8.1	-16.4	2.9
Direct nitrous oxide emissions from crop residues (IPCC)	20.0	3.6	2.3	25.8	14.6	5.2	2.6	12.2
Direct nitrous oxide emissions from nitrogen fixing crops (IPCC)	3.8	0.5	0.3	4.6	-0.5	-33.9	-16.5	-5.1
Direct nitrous oxide emissions from atmosferic deposition (IPCC)	4.7	0.9	0.6	6.2	-1.5	-3.0	-0.5	-1.7
Indirect nitrous oxide emissions from ammonia volatilisation (IPCC)	13.0	2.4	0.7	16.2	-0.1	-4.1	-12.9	-1.3
Indirect nitrous oxide emissions from leaching (IPCC via Miterra)	5.0	1.1	0.3	6.4	-6.0	-2.7	-31.7	-6.6
Direct nitrous oxide emissions from cultivation of histosols (IPCC via Miterra)	34.9	6.6	0.1	41.5	-3.2	-2.6	0.0	-3.1
Nitrous oxide emissions	215.9	39.9	10.9	266.8	0.4	-1.9	-10.2	-0.4
Total emissions	392.8	61.5	21.8	476.1	-5.1	-13.3	-20.6	-6.8

Map 1 with the related distribution diagram highlights the large differences in marginal abatement costs across EU agriculture after implementation of a 20% emission reduction target compared to the 2003-2005 base year. The differences root in two major causes: reductions in emissions, as discussed above, and how much profits are foregone due reach from that level the 80% target. The high absolute levels in some Spanish regions, Belgium, the Netherlands and Ireland can hence be mostly attributed to fact that emission levels in 2020 have not changed (much) compared to 2004. Low levels in the new Member States can be attributed to already large reductions compared to 2004 before introducing the emission 'cap'. Italy, Germany and France are example of regions with only moderate reductions compared to the 2004 levels, with sizeable differences at the regional level linked to different specialization. Generally, abatement costs are low where larger adjustments between 2004 and 2020 have taken place, such as e.g. the Massive Central in France with its extensive beef cattle production, whereas regions favourable and specialized on arable cropping as the Eastern part of England or parts of Germany, as well as regions with high organic nutrient loads such as Denmark, the Western parts of Germany or the Po flats in Northern Italy are characterized by rather high abatement costs. The distribution diagram also reveals that average marginal abatement costs in agriculture – at least given the limited mitigation offered by the model – are rather high compared to current prices in EU emission markets[2]. Marginal abatement costs with an emission standard (in thousand €/t CO_2^{eq})

Map 1. Marginal abatement costs with an emission standard (in thousand €/t CO_2^{eq})



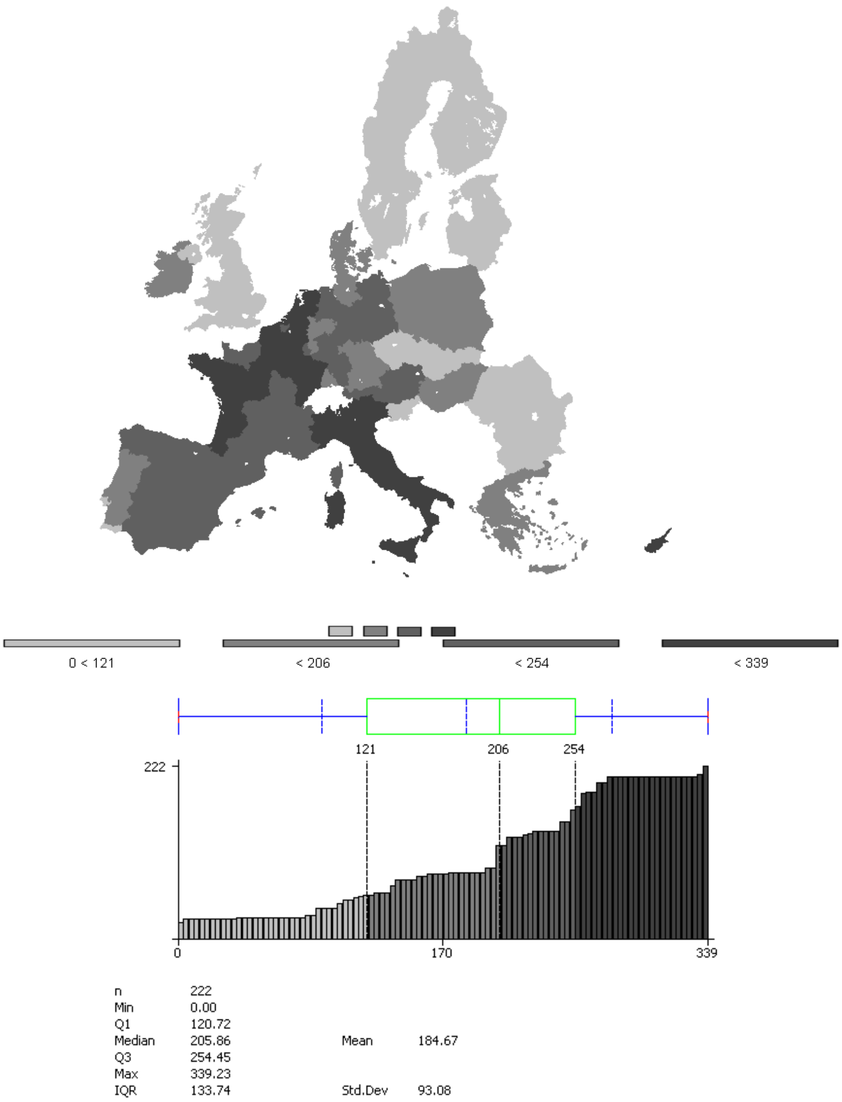
[2] Carbon prices in the ETS have varied between 0 and 30€ per ton of CO2eq in the first two faces since its implementation (between 2005 and 2009). These low prices have had to do with very moderate abatement efforts and over-supply of permits (see Ellermann and Buchner, 2007)



Source: CAPRI Modelling System, version number 5136, 06/2010

When emission trading is restricted to regions in the same MS, a bigger part of the differences prevails so that only limited welfare gains from trade are realized. That can clearly seen from the histogram: differences in marginal abatement costs in between Member States are levelled out, explaining the flat steps, but large jumps between these sections remain. We might conclude from this finding that an inclusion of agriculture into emission trading should be done at the European level. A map from the solution with trade allowed between all European region is not shown as all differences in marginal abatement are wiped out (see also Table 4).

Map 2. Marginal abatement costs with restricted trade of emission permits (in thousand €/t CO2eq)



Source: CAPRI Modelling System, version number 5136, 06/2010

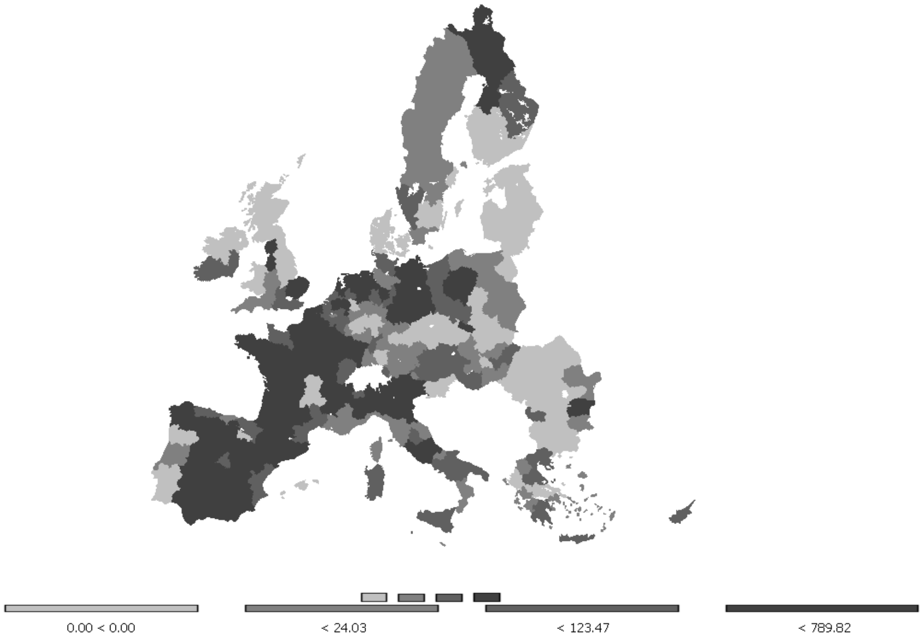
Table 4 reports permit prices from the different model solutions aggregated to country level. With an EU wide trading scheme, a clearing price of 165 €/ton CO2 emerges. As discussed below, the rather high price is not only linked to the implicit abatement costs embedded in the model, but also due to significant output price increases linked to the EU's high border protection for major agricultural products. Main buyers (see map 3) are clearly those regions characterized by high marginal abatement costs in the starting situation such as Spain, Belgium and the Netherlands.

Table 4. Evolution of regional permit prices under different trade schemes (€/t CO_2^{eq})

	20% restriction, no trade [€/t CO_2^{eq}]	20% restriction, unrestricted trade [€/t CO_2^{eq}]	20% restriction, restricted trade [€/t CO_2^{eq}]
Austria	229.8	165.6	224.6
Belgium-Lux.	275.6	165.7	257.2
Denmark	138.3	165.7	128.7
Finland	122.5	165.6	109.8
France	278.1	165.7	257.0
Germany	206.0	165.6	208.1
Greece	206.4	165.7	201.6
Ireland	176.1	165.6	174.2
Italy	291.8	165.7	274.3
Netherlands	371.5	165.6	337.0
Portugal	133.7	165.7	124.6
Spain	270.3	165.7	249.7
Sweden	121.9	165.6	105.2
United Kingdom	121.7	165.7	87.7
EU15	223.4	165.7	206.8
Cyprus	319.1	165.8	320.7
Czech Republic	29.3	165.6	0.0
Estonia	50.0	165.6	39.8
Hungary	172.7	165.6	158.4
Latvia	54.1	165.6	49.2
Lithuania	108.8	165.6	103.2
Malta	432.4	165.9	339.2
Poland	155.0	165.6	138.7
Slovac Republic	37.1	165.7	0.0
Slovenia	119.9	165.6	118.2
10 New MS	129.4	165.6	112.8
Bulgaria	14.9	165.6	0.0
Romania	23.2	165.6	2.3
Bulgaria/Romania	21.3	165.6	1.8
EU27	202.4	165.7	185.4

Source: CAPRI Modelling System, version number 5136, 06/2010

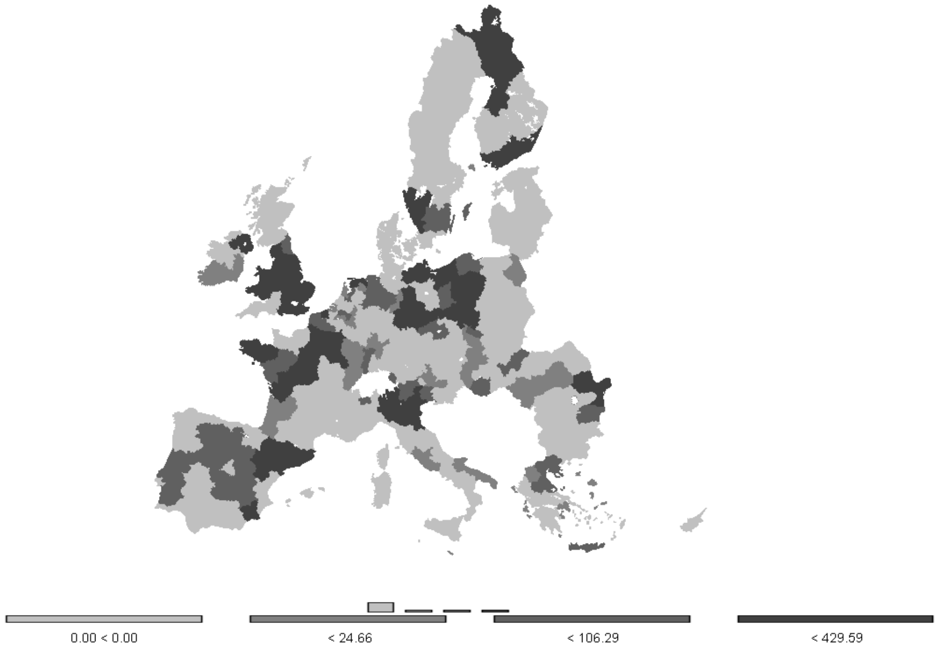
Map 3. Purchases of emission permits at the regional level with unrestricted trade (trade of permits allowed across Member State borders) (in thousand units)



Source: CAPRI Modelling System, version number 5136, 06/2010

Total purchase of permits if trade is unrestricted amounts to 25.9 MMt of CO2eq (see Map 3). In the case of restricted trade only for regions within MS, only 12.7 MMt of CO2eq are traded in the emission trading market (see Map 4). We can visualize this in these two maps by looking at the dark coloured regions, where more trade take place. Countries with a high number of regions, high marginal abatement costs and homogeneous national production structures (e.g. Netherlands, Belgium and to a certain extent Germany) would clearly profit from an unrestricted ETS, since they would be able to buy emission permits from a larger market.

Map 4. Purchases of emission permits at the regional level with restricted trade (trade of permits only allowed within Member State borders) (in thousand units)



Source: CAPRI Modelling System, version log number 5136

An interesting insight in the functioning of EU agricultural markets in general and a possible permit trading scheme offers a welfare analysis at EU 27 level. The trade in permits presented above suggest sizeable permit buying for regions specialized in meat and also milk production, due to the high emissions from manure storage and managements. The resulting increase in production costs for ruminant products and meat in general is to a large extent carried over to the consumer prices. That is seen by a moderate loss of agricultural income of 25.1 Bio € with EU wide trading, but a larger loss in consumer welfare of 28.8 Bio € . That loss is due to the fact that EU meat and dairy markets are characterized by rather high border protection, where imports enter to a larger extent under TRQs and only limited exports. Consequently, there is only limited import substitution taken place when production cost increase due to the emission cap. It thus works similar to a supply control instrument for major agricultural market. The reactions in cereals and oilseeds markets is somewhat different. For cereals, with price levels around the 155% of the administrative price at which only moderate ad-valorem tariffs are applied, the increase in production costs reduce the competitiveness of EU exports, but allows for some price increases as imports are charged with flexible levies. For oilseeds, finally, border protection is low and price movements are thus dampened by additional imports. That implies that a larger part of the adjustments has to be absorbed by the consumption side, especially by a shift to more efficient of animal products to reduce feed demand.

5. Summary and Conclusions

Based on a Takayama-Judge based spatial permit model, we simulate an emission trading scheme for GHG from agriculture, introducing a 20% cut against the 2003-2005 base year in 2020. The reduction commitment brings for many regions, especially the new MS, only moderate reductions with respect to t. That is mainly linked to decreased herds and production of beef, milk and products from sheep & goat emanating from production adjustments after the different CAP reform steps and reduced demand for beef meat in the EU. We analyse three different policy implementation. Option 1 does not allow for any trade in permits, provoking large differences in marginal abatement costs between EU regions, mainly linked to the reductions already achieved compared to the base year. It hints at possible sizeable welfare gains when trade in permits is allowed as in Option 2 where EU regions can trade with each other. With average marginal abatement costs of 165 €/ton, the emerging permit price is well above prices paid in the ETS. If trade is restricted to regions inside the same MS, only, a larger share of the original differences in marginal abatement costs is kept.

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7. Acronyms

ESAA	Effort-sharing agreement for agriculture
CAPRI	Common Agricultural Policy Regional Impact Analysis
CO2	Carbon Dioxide
ETSA	Emission trading scheme for agriculture
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
MACC	Marginal Abatement Cost Curve
MS	Member States
NPK	Nitrogen, Phosphorus and Potassium

UNFCCC United Nations Framework Convention on Climate Change

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