Greening Agricultural Support Indicators (short title)
(Mainstreaming the Environment in Aggregate Agricultural Support Measures – long title)

Nuno Vilela[1] and Rute Pinto[2]

[1] Sinergiae Ambiente, Lda., Coimbra - Portugal, n.vilela@sinergiae.pt
[2] IMAR- Institute of Marine Research, University of Coimbra, rutepinto@ci.uc.pt

Abstract
This paper attempts to adjust an OECD indicator that aggregates agricultural public support given to farmers, the Producer Support Estimate (PSE), for the external costs that arise from agricultural activities in OECD member countries. This exercise was supported by the rationale that external costs, like overuse of natural resources or environmental pollution, can be seen as an additional subsidy given by society/taxpayers to farmers for the external costs that result from farming but for which they are not asked to pay for. Society/taxpayers do it on their behalf. A conservative estimate of the external costs rising from OECD agriculture showed that they amount for about 37% ($94 million) of the PSE figure ($256 million). The external costs' figure is, indeed, considerable high and supports those that argue that agricultural policy reform should concentrate on measures to reduce the environmental burden from the sector.
Keywords: OECD countries; agriculture external costs; PSE; externalities adjusted PSE.

1. Introduction

Agriculture generates negative environmental impacts like soil erosion, water pollution and loss of biodiversity, but also provides environmental services like landscapes, recreation and amenity (Stoate *et al.* 2009). OECD (Organisation for Economic Co-operation and Development) promotes highly intensive agriculture, strongly encouraging production-enhancement through support policies. These measures can be considered as aggressive and harmful to the environment because it accentuates the overuse of natural resources (mainly soil and water), while an excessive use of agricultural inputs, like fertiliser and pesticides may result in the contamination of water resources and the harming of wildlife (Pearce *et al.* 1993; OECD 2001). Pollution costs arising from agricultural activities are paid neither by farmers nor by consumers, but are borne by society/taxpayers (Pretty *et al*. 2000). The Producer Support Estimate (PSE) is an OECD indicator that aggregates agricultural support given by the public sector to farmers (OECD 2008). A pertinent thought might be that a more accurate figure for the total support received by farmers from taxpayers should be the PSE plus agricultural pollution costs, since farmers are not asked to pay for them, and society/taxpayers do it on their behalf. A PSE indicator accounting for the agricultural external costs (and benefits) would certainly provide better insights to policy-makers on the urgent need for agricultural policy reform.

The objective of this study is to give an estimate of the external costs rising from agricultural practices in OECD member countries and subsequently add them to the most updated PSE figure. In order to achieve this, an integrated accounting framework is proposed to internalise the costs of natural resources exploitation, aiming to get a more accurate figure for the total support given by the public sector/taxpayers/society to farmers within OECD countries.

2. Methodology

The methodology used in this paper was based on a previous study (Vilela 2003) that estimated the external costs rising from agriculture for OECD member countries. A literature review on the main impacts, and their consequent costs, was undertaken for the

UK, which was then used on a benefits transfer exercise to calculate the external costs within OECD (Figure 1), based on the marginal external cost found. There was a very strong lack of specific data for many OECD countries, a benefits transfer exercise had to be undertaken. The final external cost figures for the different pollution categories do not result from the appliance of the same approach or methodology. Some were based on actual costs (eg, water pollution), others on willingness to pay studies (eg, biodiversity loss), but also on models (greenhouse gases). Across all OECD countries, clear assumptions had to be made in order to deal with many factors of variability, such as different sorts of pollution problems arising from agricultural activities, different levels of significance within the same pollution problems, different environmental conditions (eg, climate), as well as different capacities (financial and institutional resources) to perform pollution control. By transferring marginal external costs from the UK to the other OECD countries, it was assumed that the external cost per unit of agricultural pollution in the rest of the OECD countries was exactly the same as in the UK.

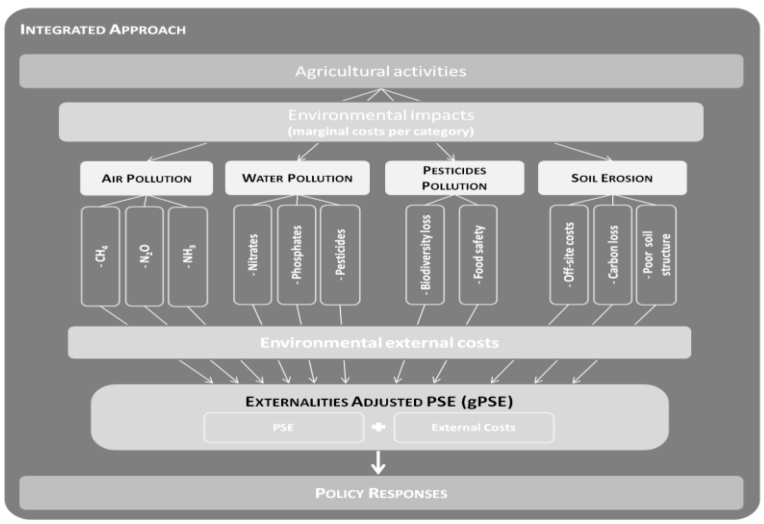

Figure 1 – Conceptual overview of the integrated approach adopted.

The specific methodological considerations undertaken on the calculations inside each of the external costs category were based on finding the marginal external costs per unit of: 1) air emissions [data for 2009 drawn from Eftec (2004) and UNFCCC (2009)]; 2) fertiliser usage [from Eftec (2004) and FAO (2009)]; 3) pesticide usage (from Foster *et al.* 1998, Pretty *et al.* 2000 and FAO 2009); 4) soil erosion [from Eftec (2004) and OECD (2009)] (Figure 1). As the sources of the UK pollution costs varied in their year prices, the final external costs for the corresponding pollution categories had to be adjusted, using the GDP deflator at market prices (H M TREASURY 2009) to bring those external costs to the same year price (2009).

The PSE figures for 2009 were drawn from OECD database (OECD 2009). OECD data did not have PSE figures for each European Union (EU) country separately, therefore, an aggregated PSE figure for all EU member countries was considered. In order to put forward the Externalities Adjusted PSE (hereafter gPSE) for 2009, the annual external costs rising from agricultural activities were added to the PSE figure, for each OECD country (Figure 1). External costs and PSE were brought into the same currency to facilitate calculations and produce the externalities adjusted PSE, in USD 2009 prices, using the Purchase Power Parity rates (OECD 2009).

Nevertheless, special attention must be given to the external costs calculations since underestimations may have occurred: a) the set of categories included in this study's calculations were not comprehensive enough to include all the important pollution problems arising from agricultural activities, like sediment removal from water by water delivery companies, costs of eutrophication and pathogens removal, opportunity costs of water abstraction for irrigation and increase in soil salinity (Middleton 1999; EEA 2003); b) inside each pollution category there were issues either with a lack of available data or with a conservative approach used, and these kept the final figures below the real scenario.

3. Results and Discussion

The marginal costs considered for this analysis are presented on Table 1. The 2002 data (Vilela 2003) was included to allow for a comparative exercise. From this comparison, it is possible to see that 2009 presented higher marginal values per unit of emission, except for NH_3 emissions marginal costs that decreased over the years.

Table 1 – Pollution categories, reference works and country from where marginal costs were obtained, 2009 and 2002 (£/tonne) marginal costs considered in this analysis.

	Reference	Country	2009 marginal costs (£/tonne)	2002 marginal costs (£/tonne)
AIR Pollution				
CH_4 emissions	Eftec, 2004	UK	577	78
N_2O emissions	Eftec, 2004	UK	8055	2961
NH_3 emissions	Eftec, 2004	UK	101	171
WATER Pollution				
Nitrogen	Eftec, 2004	UK	17	11
Phosphorus	Eftec, 2004	UK	8408	not considered
Pesticides	Eftec, 2004	UK	151	not available
PESTICIDES Pollution				
Biodiversity loss	Foster et al., 1998	UK	15862	12300
Food safety	Foster et al., 1998	UK	2837	2200
SOIL Erosion				
Off-site costs	Eftec, 2004	UK	1,7	not available
Carbon loss	Eftec, 2004	UK	15,9	not considered
Poor soil structure	Eftec, 2004	UK	32,9	not considered

Table 2 presents the annual external costs rising from agriculture activities in each OECD member country for the 2009 year, at USD 2009 prices. The costs are given per OECD country and per pollution category. An aggregate pollution costs figure per country and a total external cost figure per pollution category, aggregating every OECD country member, were also put forward, as well as the overall external costs in OECD member countries, aggregating every country and pollution category. As it was not the purpose of this study to perform a per country analysis of the figures presented, only some features are highlighted below. A major feature was the USA external cost figure, which was the highest achieved value, followed by Mexico, France and Canada. Moreover, almost all countries increased their total external costs associated with agricultural activities between 2002 and 2009, except for Australia.

Table 3 shows the Externalities Adjusted Producer Support Estimate (which could also be designated as the "green PSE"- gPSE) figures for each OECD member country, and the overall (all countries aggregated) externalities adjusted PSE figure (converted into 2009 prices).

Table 2 – Annual External costs for 2009 rising from agriculture in each OECD country (the 2002 data was also included to allow for the external costs comparison over the years).

EXTERNAL COSTS $m	AUS	AUT	BEL	CAN	CHL	CZE	DEU	DNK	ESP	EST	FIN	FRA	GRC	HUN	IRL	ISL	ITA
AIR Pollution																	
CH_4 emissions	2741,1	151,0	217,0	925,5	257,4	117,2	1132,9	173,8	785,3	21,0	78,8	1834,5	155,8	108,4	455,2	11,4	640,6
N_2O emissions	773,4	159,7	178,7	1343,6	288,8	229,0	1816,6	219,9	802,1	31,9	152,7	2089,9	207,7	227,6	264,3	11,8	763,8
NH_3 emissions	0,0	9,1	9,6	0,0	0,0	10,8	87,6	11,4	51,3	1,4	5,1	110,2	9,2	10,2	16,3	0,0	56,9
WATER Pollution																	
Pesticides	-	37,8	103,3	-	213,2	56,5	309,1	29,3	-	4,4	18,6	650,2	117,4	106,4	29,7	0,1	555,1
Nitrates on drinking water	11,7	1,4	-	25,6	6,8	6,0	27,9	3,3	13,9	0,5	3,1	33,9	2,5	4,9	6,4	0,2	10,9
Phospahate on drinking wate	65,1	1,8	-	55,6	9,5	3,2	23,3	2,0	26,2	0,6	6,2	39,5	5,6	4,4	6,7	0,4	17,0
PESTICIDES Pollution																	
Biodivesity/Wildlife losses	-	46,6	141,6	-	263,0	77,5	381,4	36,2	504,0	5,5	22,9	802,3	161,0	131,3	40,7	0,1	684,9
Human Health	-	8,3	25,3	-	47,0	13,9	68,2	6,5	90,1	1,0	4,1	143,5	28,8	23,5	7,3	0,0	122,5
SOIL Erosion																	
Off-site costs	10,9	3,2	2,0	104,7	2,9	7,4	27,7	5,6	29,0	1,4	5,2	42,6	5,9	10,6	2,5	0,0	16,0
carbon loss	103,4	30,1	18,4	989,0	27,8	69,7	261,9	53,3	274,0	13,1	49,5	402,3	55,9	100,5	23,9	0,2	150,9
poor soil structure	213,8	62,1	38,1	2044,3	57,6	144,1	541,5	110,2	566,5	27,0	102,3	831,6	115,6	207,8	49,4	0,3	311,9
TOTAL External Costs 2009	3919,4	511,1	734,0	5488,4	1174,2	735,2	4678,1	651,6	3142,4	107,7	448,6	6980,6	865,5	935,6	902,3	24,5	3330,5
TOTAL External Costs 2002[1]	4385,1	112,4	251,5	1247,4	-	163,4	1133,6	186,0	969,2	-	87,2	2586,0	282,0	407,9	189,4	2,3	1783,5

EXTERNAL COSTS $m	JPN	KOR	LUX	MEX	NDL	NOR	NZL	POL	PRT	SLO	SVK	SWE	SWZ	TUR	UKD	USA	Total
AIR Pollution																	
CH_4 emissions	620,6	429,4	14,3	1619,5	399,5	93,0	976,3	517,8	191,4	46,4	41,6	132,8	134,3	690,1	759,2	8264,1	9807,0
N_2O emissions	422,1	234,0	13,2	277,5	291,9	79,0	379,8	921,0	128,6	35,5	80,6	199,9	96,6	368,0	1071,2	8841,6	9561,6
NO_x emissions	0,0	0,0	0,7	0,0	16,8	3,2	0,0	41,2	6,6	2,6	3,7	6,5	9,1	0,0	39,3	0,0	389,0
NH_3 emissions																	
WATER Pollution	699,2	245,7	-	1465,1	94,6	5,7	36,3	158,3	132,9	13,2	17,1	21,7	21,5	392,4	206,3	3411,2	2231,2
Nitrogen	7,7	6,8	0,3	18,3	4,0	1,7	4,3	25,4	1,7	0,5	2,2	2,5	0,9	25,2	18,1	196,7	159,1
Phosphorus	37,1	8,3	0,1	19,4	1,0	2,0	32,2	25,0	4,4	0,7	0,5	1,8	1,2	57,5	16,7	330,3	266,9
Pesticides																	
PESTICIDES Pollution	862,7	336,9	-	1807,6	116,7	7,1	49,7	217,1	163,9	16,3	21,1	26,7	26,6	537,9	254,5	4676,5	3299,0
Biodiversity loss	154,3	60,3	-	323,3	20,9	1,3	8,9	38,8	29,3	2,9	3,8	4,8	4,8	96,2	45,5	836,5	590,1
Food safety																	
SOIL Erosion																	
Off-site costs	10,0	3,7	0,1	58,3	2,4	1,9	1,1	29,1	2,6	0,4	3,2	6,1	0,9	49,6	14,0	377,8	277,8
carbon loss	94,2	35,0	1,4	551,1	23,1	18,3	10,3	275,0	24,7	3,8	30,3	57,8	8,9	468,2	132,6	3569,0	2624,0
poor soil structure	194,6	72,3	2,8	1139,3	47,8	37,8	21,3	568,4	51,0	7,9	62,6	119,4	18,4	967,8	274,2	7377,3	5424,1
TOTAL External Costs 2009	3102,4	1432,4	32,9	7279,5	1018,8	251,1	1520,4	2817,1	737,1	130,2	266,8	579,9	323,3	3652,9	2831,7	37881,0	34629,7
TOTAL External Costs 2002[1]	285,9	434,7	2,7	128,3	308,3	50,6	317,9	436,5	345,6	97,7	-	113,4	77,9	657,5	1067,9	11379,2	29491,1

Note:
$2009 prices, million
[1] $ 2002 prices, million

Table 3 – Externalities' adjusted PSE for the 2002 and 2009 year, at 2009 prices.

		AUS	CAN	CHL	EU	ISL	JPN	KOR	MEX	NOR	NZL	SWZ	TUR	USA	TOTAL
TOTAL External Costs (£ m)															
	2002	5033,6	1481,3	-	12497,8	2,8	339,5	516,2	152,4	60,1	377,5	92,5	780,8	13513,1	34847,4
	2009	2563,3	3589,4	875,2	21439,6	16,0	2380,8	677,1	5498,1	167,1	956,0	222,3	1974,2	21168,7	61527,7
TOTAL External Costs ($ m) [1]															
	2002	7669,4	2256,9	-	19042,4	4,2	517,3	786,5	232,2	91,5	575,1	140,9	1189,7	20589,3	53095,6
	2009	3919,4	5488,4	1174,2	32334,5	24,5	3102,4	1432,4	7279,5	251,1	1520,4	323,3	3652,9	37881,0	94079,0
PSE ($ m)															
	2002	1362,7	7114,8	-	149099,3	141,0	44597,1	36424,5	14037,2	2752,0	162,9	4897,1	16900,4	46811,5	324300,5
	2009	990,9	6721,9	383,8	119404,6	124,8	44784,4	17619,4	5572,1	3366,2	50,3	5847,0	20170,0	31423,2	256458,5
Externalities Adjusted PSE ($ m) [2]															
	2002	9032,2	9371,7	-	153823,1	145,2	45114,4	37211,0	14269,4	2843,5	738,0	5038,0	18090,1	67400,8	377396,1
	2009	4910,4	12210,3	1558,0	151739,1	149,2	47886,7	19051,8	12851,5	3617,4	1570,7	6170,3	23822,8	69304,2	350537,5

Note: 2009 prices, million
[1] Total external costs in £ were converted into $ using PPPs
[2] PSE plus Total External Costs

From this table it is possible to observe that 5 countries (Australia, Chile, Mexico, New Zealand and USA) presented higher external costs associated with agriculture practices, than the subsidies given to producers (PSE), while the remaining countries presented higher subsidies than external costs. Moreover, significant higher external costs were achieved for countries such as Mexico, Japan or Korea in 2009, comparatively to 2002, concomitant with a PSE reduction. This unusual fact may be explained by the unavailability of data for most of environmental pollution emissions for these countries in 2002, which reduced the total external costs figures. Regarding PSE trends, EU had the highest PSE figure amongst all OECD members, which was more than two times larger than the second largest PSE figure, the USA. This trend was also observed for the 2002 year. From Table 3 it is also possible to see that there has been a slight decrease in the externalities adjusted PSE in 2009, comparatively to 2002, mainly driven by Australia and Korea.

The most important feature to highlight from this study is that the overall external costs rising from the OECD agricultural sector in 2009, $94 billion, is equivalent to 37% of the total support given to farmers in OECD countries, which stands at $256 billion. This more accurate and environmentally adjusted picture of 2009 PSE, including the annual external costs from the sector, reveals a remarkably higher figure, $350 billion. Interestingly, these gross estimates suggest that the external costs contribution passed from 16% to 37% from 2002 to 2009, respectively, despite the decreasing trend verified in the supports given to producers. This may be due to 1) the increase in the marginal external costs per emission; 2) the inclusion of more environmental categories to assess total external costs; and 3) more countries were included in the analysis (eg, Chile and new EU members).

Moreover, economic differences among OECD countries can also raise the question of not all OECD countries being able to spend the same amount of money on pollution control. Therefore, using values based on UK figures would lead to an over- estimation of pollution costs in countries with less economic resources to tackle pollution (like Portugal, Greece, Spain, Mexico, Hungary, etc), that despite good-willing do not have the economic resources to accomplish it. Thus, using values based on UK figures might have the advantage of bringing pollution costs for those less wealthy OECD countries closer to the pollution control budget that those countries would be willing to spend in order to reasonably overcome their pollution problems. On the one hand, it might be a source of over-estimation, but, on the other hand, it might be a figure that brings closer to the real external costs for these less wealthy OECD member countries. However, for some other countries, like the USA and maybe Japan or Germany, which might spend a higher percentage of their budget on pollution control, the figures drawn from the UK might lead to an under- estimation of their agricultural external costs. Therefore, it becomes essential to integrate countries realities into gPSE calculation allowing then a comparison with the results achieved using UK as the base country.

The external costs' figure is, indeed, considerable high and supports those that argue that agricultural policy reform should concentrate on measures to reduce the environmental burden from the sector (eg, Vilela 2003; Stoate *et al.* 2009).

4. CONCLUSIONS

This work intended to highlight the impacts caused by agriculture on ecosystems, measured through the environmental external costs associated with this activity, and to analyse the consequences of a green PSE usage, based on a previous analysis (Vilela 2003). By internalizing the environmental external costs rising from agriculture into the OECD indicator that aggregates agricultural support given by the public sector to farmers (the PSE), a more realistic and equitable indicator is reached. With such indicator society/taxpayers can expect the development of better policies, with less negative environmental externalities, undertaken by politicians and high level organizations, like OECD.

The gPSE exercise identified two main future research topics: 1) a gap analysis should be undertaken, covering more (potential) environmental impacts (eg, pesticides effect on climate changes issues), and 2) to integrate countries realities into gPSE calculation (instead of using UK as reference).

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