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THE COMMON AGRICULTURAL POLICY AND THE GREENHOUSE GASES EMISSIONS

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The Common Agricultural Policy and the greenhouse gases emissions

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Abstract.

The evolution of greenhouse gases emissions in the EU-15 countries is accessed. While the absolute level of emissions turns out to be declining in the last thirty years in EU-15 Member States, emissions per output tend to rise. A relationship between the adoption of the Common Agricultural policy and the emissions level can be detected for Spain, Austria, Finland and Sweden.

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1. Introduction

It is well known and documented that the implementation of the Common Agricultural Policy (CAP) brought about important productivity increases in member state agricultural sectors.[1]

For more than 30 years the driving engine of agricultural development in the European Economic Community was the CAP price policy. Highly supported producers prices led to the adoption of new, or improved, technologies based upon higher mechanization, better plant and animal breeding, and increased use of fertilizers and pesticides. This policy produced not only the initially desired results but ended by overshooting some of them.

The sound increases in productivity boost domestic supply, bringing self-sufficiency for almost all the agricultural commodity markets and generated sizeable excess supplies in quite a few. For crops the price induced increased supply was to a large extent due to yield increases.

But it was not until the early nineties that policy makers started to worry about the overshooting effects of CAP. The McSharry reform of 1992 was the first sign of a different approach to farm income support as well as the first alert to the agriculture's role in both environment protection and disruption.

Amidst the ongoing environment discussions and world wide preoccupations, greenhouse gases (GHG) emissions play an important role. Although agriculture is not the major responsible for GHG emissions it cannot be excluded from the list of important contributors to the dangerous green house effect, which consequences on future climate changes are not fully known but, very likely, will be important.

The theme of gaseous emissions from agricultural activity has been addressed by individual researchers as well as by international organizations like the Food and Agriculture Organization (FAO) of the United Nations (UN) and the Organization for Economic Cooperation and Development (OECD). FAO[2] estimated gaseous emissions of ammonia (NH_3), nitric oxide (NO) and nitrous oxide (N_2O) from agricultural land in

[1] Annual Reports on the Situation of Agriculture, published by the European Commission, clearly illustrate this behaviour although the rates in productivity increase differ among Member states.
[2] FAO (2001)

17 regions of the world in 1995. OECD[3] evaluated the agricultural GHG emissions in its member countries (except for Korea and Mexico) for the 1990-92 and 1995-97 periods. Both studies are concerned with the methods and techniques to measure emissions and its application to get global emission values originating in both crop and livestock production. None of them attempts to relate emission values with economic indicators or computes time series long enough to give an idea of the evolution of emission levels in the recent past.[4]

The purpose of this work is then twofold. First to establish, for the EU-15 member states, as long as possible time series for GHG emissions, expressed in Mg (metric tonnes) of CO_2 as well as in terms of Mg of CO_2 per Agricultural Gross Value Added (AgGVA). Secondly, try to relate the evolution of these values with the presence or absence of CAP implementation.

In the next section the sources of emissions are identified and the evaluation process used is described, given the data availability restrictions. In section 3. the evolution of emission levels is analysed and average annual change rates are computed. Section 4. is devoted to the attempt of relating this evolution with the agricultural policy pursued in the EU. Some concluding remarks are presented in the last section.

2. Greenhouse gases emissions from agriculture

The green house effect is the result of emissions of three gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

Emissions of carbon dioxide result from both croplands and permanent grasslands; methane is produced by livestock and by rice cultivation; and nitrous dioxide has both direct and indirect origins.

Direct emissions of N_2O come from the utilization of mineral fertilizers, the cultivation of organic soils (histosoils), and crop residuals and excreta from animals. Indirect emissions are due to NH_3 emissions/deposition from synthetic fertilizer use and grazing animals and are also due to nitrogen (N) leaching/runoff from synthetic fertilizer use and grazing animals.

In order to compute the emissions from these different sources we need to quantify:

a) crop, permanent grass, histosoils and rice cultivated areas;

[3] OECD (2001)

[4] The OECD study only compares the 1990-1992 and the 1995-97 periods.

b) crop residuals;
c) number of animals in each category (dairy cows, other cattle, pigs, sheep and goats, horses and donkeys, poultry and hens, and buffalos);
d) animal excreta from grazing animals;
e) amount of N resulting from fertilizers applied;
f) leaching/runoff coefficients;
g) emission coefficients for the different sources.

While crop, permanent grass and rice cultivated areas and the number of animals are available from the EUROSTAT, AgrIs database, the area of histosoils cultivated in the EU member states is not easy to obtain. Values for items b), d) and f) are not available also. Nevertheless the error involved in not computing emissions from these sources is negligible. The same can be said for rice cultivation (for which CH_4 emission coefficients are hard to establish), insofar as only four EU-15 countries produce rice, and the volume of emissions from this source is also relatively small.

As to the emission coefficients, we used the EMEP/CORINAIR[5] values that are showing in Tables A.1 to A.5 in the Annex A.

The annually volume of GHG emissions for each of the fifteen countries was then computed using the following equations:

Carbon dioxide

$$CO_2\ (Mg) = 15 \times Arable\ land\ area\ (ha) + 10 \times Permanent\ grassland\ area\ (ha)$$

Methane emissions

$$CH_4\ (Mg) = \sum_i ef_i \times Number\ of\ animals_i + \sum_i mm_i \times Number\ of\ animals_i$$

Nitrous oxide

$$N_2O\ (Mg) = 0.0125 \times Total\ N\ applied\ (Mg) + 0.01 \times (NH_3 + NO)\ emitted\ (Mg)$$

Ammonia

$$NH_3\ (Mg) = \sum_j cf_j \times N\ applied\ with\ fertilizer_j\ (Mg) + \sum_k mm_k \times Number\ of\ animals_k$$

Nitric oxide

$$NO\ (Mg) = 0.007 \times Total\ N\ applied\ (Mg)$$

[5] European Environment Agency (2004)

The volume of GHG emissions in terms of CO_2 equivalent is then given by

$GHG\ (Mg\ of\ CO_2\ equivalent) = CO_2\ (Mg) + 21\times\ CH_4\ (Mg) + 310\times N_2O\ (Mg)$

where 1, 21 and 310 are the Global Warming Potentials (GWP's) over 100 years for the three gases.

The emissions values showing in Annex B were computed in this manner.

3. Evolution of greenhouse gasses emissions in the recent past

From Figure B.1 in Annex B the impression one gets is that the level of GHG emissions has been declining in absolute terms for the vast majority of EU Member States. In fact the only exception is Germany that experiences a sudden increase in emissions after 1991 (year of reunification) which is not surprising given the increase in arable land and livestock numbers. But after this jump, in more recent years, the emissions tend again to decrease.

It is also interesting to compare the values we obtained with those of OECD (2001). The results are showing in Table 3.1.

The first conspicuous fact emerging from the table is that our computations give much larger emission values. Though, this is not surprising due to one important difference between the two approaches. While in the OECD study, emission coefficients from croplands and permanent grasslands were equal to 3.7 and 1 Mg of CO_2 / ha / year respectively, we used the EMEP/CORINAIR recommended values of 15 and 10 Mg of CO_2 / ha / year.[6] In addition the OECD study includes emissions from fossil fuel combustion in agriculture, which are not taken into account in our computations, and do not seem to be very important.

Given these differences the two sets of figures in Table 3.1 look much more compatible, even

because different countries have different proportions of crop and permanent grasslands.

[6] Based on more recent measures for Europe, European Environment Agency (EMEP/CORINAIR) recommended values are 15 ± 5 and 10 ± 5 Mg of CO_2 / ha / year for croplands and permanent grasslands respectively.

Table 3.1 - Total national emissions of agricultural greenhouse gases

(million Mg)

	OECD (2001)		Our computations	
	1990-92	**1995-97**	**1990-92**	**1995-97**
Belgium	13	15	23	24
Denmark	18	18	47	48
Germany	70	65	244	275
Greece	15	14	56	45
Spain	43	43	349	339
France	98	95	422	420
Ireland	20	20	60	61
Italy	50	51	215	192
Luxembourg	1	1	2	2
Netherlands	26	27	36	35
Austria	5	5	46	45
Portugal	8	8	48	47
Finland	7	6	41	35
Sweden	10	10	52	49
United Kingdom	55	54	231	220

Sources: OECD (2001) and computed

In the whole our computations are 2 to 5 times larger than the OECD ones, the only exceptions to this pattern being Spain and Austria. For Austria the reason for our figures being almost ten times larger is that in the OECD study CO_2 emissions are not included for this country. As to Spain there is no such indication, but the size of its agricultural sector being about 2/3 of the French one raises the suspicion that OECD values are under estimated.

But from an economic analysis point of view the interesting exercise is to relate these values with economic variables and analyse its evolution as well as its possible connections with policy decisions.

OECD (2001) suggests that one can get information on the economic efficiency of energy use in agriculture and its environment implications by calculating GHG emissions per unit of output.

The most obvious (and also easy to get data on) variable to use as output indicator is the agriculture value added in real terms. Using EUROSTAT, AgrIs data for the Agricultural Gross Value Added (AgGVA) and GDP deflator we computed values showing in Table 3.2

Table 3.2 - GHG emissions in CO_2 equivalent / Real AgGVA (Mg of CO_2 / Mio EUR)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Belgium								771,684	736,475	761,223	747,213	765,481	796,685	785,177	830,207	813,757
Denmark	878,856	907,395	1,098,102	1,032,427	969,124	975,382	1,129,450	1,252,093	1,239,822	1,136,167	1,316,370	1,081,534	1,159,648	1,113,005	1,350,709	1,335,071
Germany																
Greece																
Spain																
France								1,126,260	1,178,767	1,102,660	1,251,464	1,319,757	1,335,231	1,373,575	1,439,237	1,497,634
Ireland																
Italy								350,143	397,235	432,343	422,833	473,886	502,643	520,228	542,407	593,485
Luxembourg													1,504,734	1,395,624	1,401,314	1,420,810
Netherlands														442,489	427,207	415,498
Austria																
Portugal																1,392,495
Finland			871,763	818,587	957,139	1,081,439	1,131,963	1,017,831	1,086,498	924,410	907,208	862,226	913,917	901,218	1,297,397	1,257,934
Sweden								1,274,790	1,116,546	1,146,534	1,495,880	1,261,439	1,553,976	1,635,549	1,802,404	1,795,602
U K	1,057,829	1,154,046	1,304,781	1,334,098	1,445,669	1,548,716	1,563,344	1,550,996	1,430,226	1,362,925	1,537,724	1,409,540	1,651,258	1,860,151	1,917,921	1,910,797

Source: Computed

Table 3.2 (cont.) - GHG emissions in CO_2 equivalent / Real AgGVA (Mg of CO_2 / Mio EUR)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Belgium	692,968	745,959	754,662	775,082	798,652	811,285	859,914	844,253	833,392	891,279	964,890	915,049	896,594	1,007,566	980,914
Denmark	1,186,630	1,196,295	1,282,730	1,363,778	1,383,104	1,311,489	1,161,350	1,298,912	1,368,570	1,709,338	1,775,996	1,562,911	1,286,914	1,631,867	1,695,087
Germany			1,786,714	1,853,509	1,849,991	1,866,902	1,729,087	1,682,275	1,709,694	1,815,650	1,786,231	1,574,211	1,382,199	1,711,942	1,806,440
Greece					662,549	646,205	670,500	740,872	307,035	330,332	954,808	1,003,769	1,009,988	792,864	828,856
Spain		1,363,872	1,424,329	1,713,294	1,771,944	1,670,343	1,764,422	1,572,596	1,562,026	1,559,412	1,530,473	1,448,016	1,373,682	1,471,945	1,383,977
France	1,369,410	1,317,641	1,497,193	1,431,823	1,493,497	1,397,032	1,360,831	1,376,516	1,391,010	1,355,047	1,380,749	1,386,139	1,408,007	1,448,221	1,507,686
Ireland		1,857,503	1,974,008	1,761,309	1,922,332	1,980,000	2,001,974	2,030,668	2,167,798	2,445,778	2,771,430	2,626,301	2,966,068	3,269,024	3,194,371
Italy	562,547	663,988	623,842	653,488	757,394	772,074	816,266	730,907	715,846	731,877	742,139	758,939	746,324	779,545	771,768
Luxembourg	1,281,656	1,338,661	1,652,579	1,446,719	1,467,412	1,525,595	1,400,389	1,569,456	1,815,970	1,649,672	1,576,318	1,813,638	1,746,121	1,744,190	1,818,499
Netherlands	363,502	364,073	356,871	366,007	396,591	370,430	361,527	372,066	402,007	389,235	421,213	402,831	407,000	443,952	449,595
Austria		1,157,818	1,189,697	1,305,300	1,316,611	1,306,522	1,399,294	1,540,653	1,645,350	1,725,995	1,727,808	1,698,151	1,604,313	1,709,684	1,788,636
Portugal	1,222,129	1,196,587	1,336,391	1,768,030	2,086,081	1,841,104	1,753,620	1,699,718	1,933,225	1,985,529	1,742,662	1,901,166	1,588,667	1,687,352	1,639,064
Finland	1,051,844	1,068,960	1,362,474	1,744,704	1,742,501	1,815,638	2,136,206	2,192,627	2,307,042	3,374,710	2,916,531	2,537,808	2,578,686	2,583,905	2,778,691
Sweden	1,704,009	1,911,421	2,232,946	2,578,538	2,831,913	3,009,040	2,949,999	2,899,230	2,842,495	3,045,891	3,472,281	3,034,335	3,339,859	3,357,094	3,405,344
U K	1,873,435	1,967,259	1,995,036	2,016,523	1,872,090	1,793,694	1,783,591	1,871,766	1,980,445	2,177,831	2,229,522	2,194,443	1,790,573	1,570,100	1,787,716

Source: Computed

Looking at the table it is evident that, contrary to its absolute values counterparts, GHG emissions per Agricultural Gross Value Added have been increasing for the last thirty years. The same conclusion can be drawn if we take the 3 year moving averages of these values, as depicted in Figure 3.1.

To get a more accurate perspective on this evolution we estimated the linear trends for the values in Table 3.2 as well as for its 3 year moving averages values.

For that purpose we estimated the following equation for each country

[3.1] $$\frac{GHG}{AgGVA} = \alpha + \beta T$$

where $GHG/AgGVA$ = volume of emissions in Mg of CO_2/AgGVA per year

T = year

and α and β are parameters

The results are presented in Table 3.3, where average annual rates of change are also computed.

Table 3.3 – Emissions/value added: trend and annual rate of change

	Linear trend coefficient β		Annual average rate of change (%)	
	Original series	Three year moving averages	Original series	Three year moving averages
Belgium	9522.29	9302.78	1.05	1.15
Denmark	21082.76	19816.99	2.21	1.69
Germany	-16983.83	-26303.65	0.05	-0.57
Greece	28658.68	38303.85	2.26	3.63
Spain	-12887.50	-21880.42	0.11	-0.56
France	9984.73	8354.74	1.28	1.18
Ireland	116089.60	121439.20	4.26	4.86
Italy	18771.49	18914.40	3.50	3.23
Luxembourg	24156.15	26314.02	1.06	1.32
Netherlands	1581.48	1988.66	0.09	0.08
Austria	49392.57	50114.38	3.40	3.09
Portugal	27477.08	30171.91	1.09	1.98
Finland	79187.80	81855.59	4.23	4.32
Sweden	111869.40	116337.20	4.36	5.12
United Kingdom	26211.73	27282.10	1.76	1.37

Source: Computed

While the annual average rates of change are all positive for the original series, its moving averages values confirm the decreasing trend observed for Germany and Spain.

The German case may find explanation in the fact that computations were made only for post reunification years, which softens the emission effects of a much higher intensity type of agriculture in the former West Germany. As to Spain there is no clear cut explanation for the reduction in the emissions/value added ratio.

The observed tendency for decline in the volume of emissions can be seen as positive in view of the Kyoto protocol targets, although agricultural emissions represent only around 8 percent of total emissions in OECD countries.[7]

But our objective was a little more ambitious that the simple computation of emissions evolution figures. The idea was to relate this evolution with the implementation of CAP. This is tried in the next section.

[7] OECD (2001)

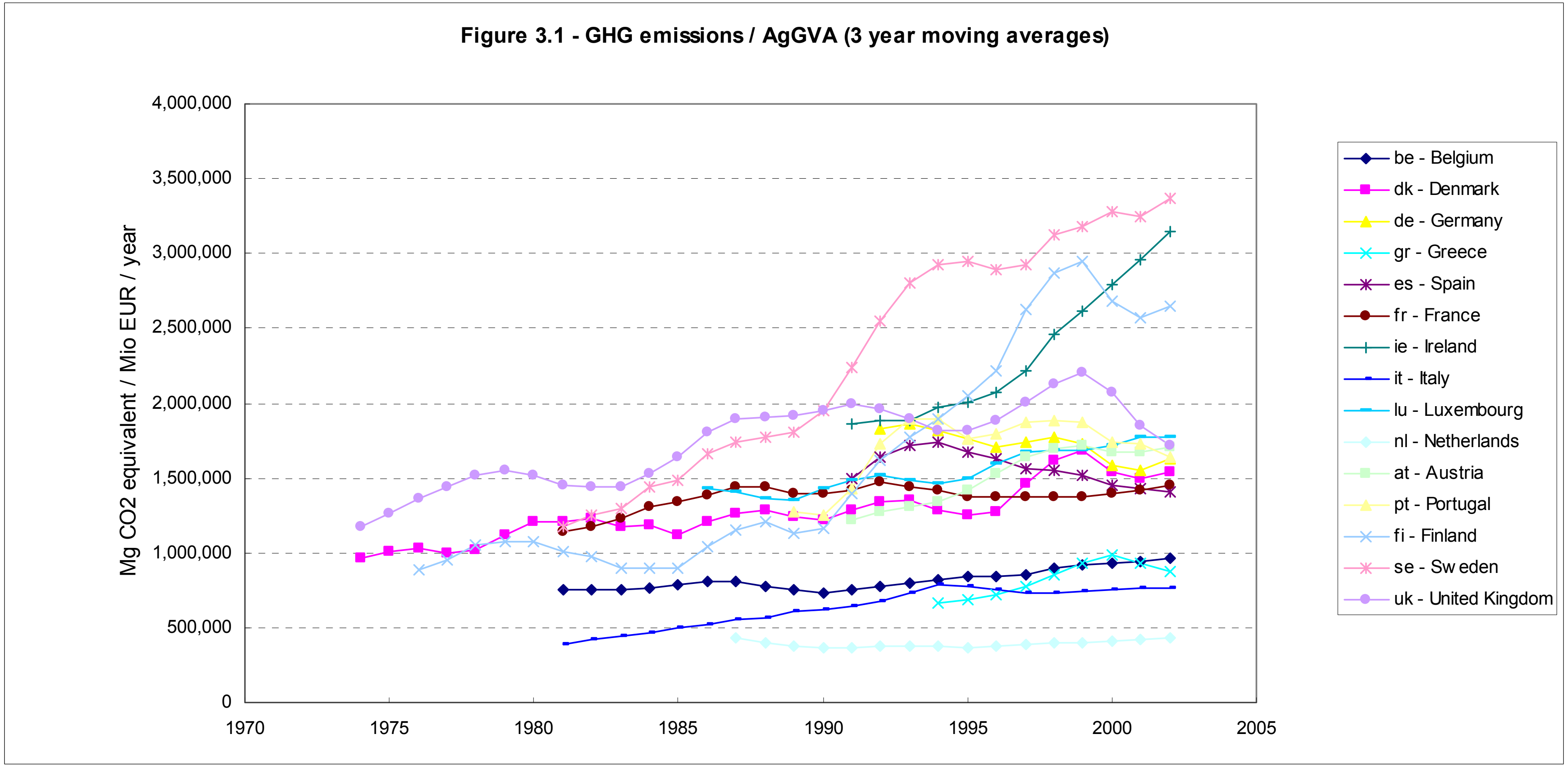

Figure 3.1 - GHG emissions / AgGVA (3 year moving averages)
Mg CO2 equivalent / Mio EUR / year
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1970
1975
1980
1985
1990
1995
2000
2005
be - Belgium
dk - Denmark
de - Germany
gr - Greece
es - Spain
fr - France
ie - Ireland
it - Italy
lu - Luxembourg
nl - Netherlands
at - Austria
pt - Portugal
fi - Finland
se - Sw eden
uk - United Kingdom

4. Does the Common Agricultural Policy matter?

One possible way to access the existence of a relationship between CAP implementation and GHG emissions is to compare its levels before and after a country joined the EU. Unfortunately this exercise cannot be performed for the fifteen member states insofar our database starts in 1973 and thus there are no observations for the six founding fathers of the European Economic Community *before* they joined the Community. The same applies to Denmark, Ireland and the United Kingdom that became members in 1973. Our analysis is then confined to the remaining six countries: Greece, Portugal, Spain, Austria, Finland and Sweden.

To access the possible impact of CAP in the evolution of GHG emissions we modified the trend equation [3.1] that was estimated for each country.

The modification consisted in adding a new variable, defined as $(X_1 - X_2)$, to equation and thus getting the absolute volume of GHG emissions

[4.1] $$GHG = \alpha + \beta T + \gamma (X_1 - X_2)$$

$$\text{where} \quad X_1 \begin{cases} = 1 \text{ in the years before joining the EU} \\ = 0 \text{ in the years after joining the EU} \end{cases}$$

$$\text{and} \quad X_2 \begin{cases} = 0 \text{ in the years before joining the EU} \\ = 1 \text{ in the years after joining the EU} \end{cases}$$

So the variable $(X_1 - X_2)$ takes the value 1 in the years before EU accession and the value -1 in the years after accession.

Then, if $\gamma > 0$ and statistically significant we conclude that in pre-accession years the volume of GHG emissions was increased. In other words, after accession the volume is decreased.

If $\gamma < 0$ and statistically significant we conclude that after accession the volume of GHG emissions increases. In other words, adoption of CAP caused higher volumes of emissions.

If γ is not statistically significant, then nothing can be concluded.

The estimation results for equation [4.1] are shown in Table 4.1 and the graphs for the adjustments are in Annex C.

Table 4.1 – GHG emissions evolution estimation results

Country	γ	t-statistic	Probability (%)	R^2
Spain	-13814552	-3.527632	0.15	0.83
Greece	-1539395	-1.236942	22.64	0.58
Austria	234991.9	2.801867	0.91	0.95
Portugal	293194.7	0.429116	67.11	0.86
Finland	2061209	7.945206	0.00	0.86
Sweden	1227443	4.999747	0.00	0.92

Source: estimated

For Spain, Austria, Finland and Sweden it appears that CAP adoption had an impact on the GHG emissions level. While for Spain the level of emissions increased after adoption, for the remaining three countries it looks like the CAP had a beneficial effect on the level of emissions. The γ coefficient for Greece and Portugal is not significantly different from zero and so nothing can be concluded in theses cases. The same conclusions are apparent from the graphs in Annex C where the change in emissions level is well marked for Spain, Austria, Finland and Sweden.

If we now turn to the analysis of the evolution of emissions per value added, the sample of countries is further reduced to three: Austria, Finland and Sweden. This is because, as it can be seen in Table 3.2, for Spain, Greece and Portugal the absence of values for AgGVA before EU accession does not allow the computation of emissions per value added.

Using the equation [4.1] with the left hand-side divided by AgGVA we obtained the estimates of γ showing in Table 4.2 and the graphs of Annex D.

Table 4.2 – GHG/AgGVA emissions evolution estimation results

Country	γ	t-statistic	Probability (%)	R^2
Austria	-77899.95	-2.177702	5.21	0.91
Finland	-436357.5	-4.915332	0.00	0.89
Sweden	27381.09	0.333733	74.19	0.94

Source: estimated

Table estimates reveal that for Austria and Finland GHG/AgGVA emissions increased with the adoption of CAP, while for Sweden nothing can be concluded.

5. Concluding remarks

Despite the limitations of the analysis, namely not including emissions from histosoils cultivation, from crop residuals, leaching/runoff and fossil fuel combustion, the evidence gathered leads to the general conclusion that, during the last thirty years, the GHG emissions originated in the agricultural sectors of the EU-15 member States under observation experienced a decline in its absolute level.

Amazingly the evolution for emissions per value added point towards the opposite direction. Except for Germany and Spain, emissions per output show a positive trend.

The decline in the absolute volume of emissions can be explained by two major facts. On the one hand arable land has remained constant or even decreased for a few countries. On the other hand after the eighties the reduction in the amount of nitrogen applied in fertilization is a common feature for all countries.

The increase in emissions per output denounces a loss in economic efficiency in energy use in agriculture.

Relationships between CAP adoption and the absolute level emissions could be detected for Spain, Austria, Finland and Sweden. While for Spain it looks like the policy effect was negative, for the other three countries it looked positive.

On the other hand CAP adoption seems to have caused jumps in the level of emissions per value added in Austria and Finland while no effect could be detected for Sweden.

A final word of caution has to be said. The coefficients showing in tables of Annex A were the same for all countries in our sample. The analysis would benefit from the adoption of specific coefficients according to each country particular conditions in land use and livestock management.

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ANNEX A

Table A.1 – Carbon dioxide emission coefficients

(Mg of CO_2 / ha / year)

	CO_2 emission coefficients
Cropland	15
Permanent grassland	10

Source: EMEP/CORINAIR

Note: Mg = Megagramme = 1 metric tonne

Table 2.2 – Methane emission coefficients

(Kg of CH_4 /animal /year)

	CH_4 emission coefficients	
	Enteric fermentation	**Manure management**
Dairy cows	100	14
Other cattle	48	6
Sheep	8	0.19
Pigs	1.5	3
Horses	18	1.39
Mules and asses	10	0.76
Goats	5	0.12
Poultry	not relevant	0.078

Source: EMEP/CORINAIR

Table A.3 – Nitrous oxide emission coefficients

	N_2O emission coefficients
Direct emissions	0.0125 Mg of N_2O / Mg of N applied / year
Indirect emissions	0.011 Mg of N_2O / Mg of (NH_3 + NO) applied / year

Source: EMEP/CORINAIR

Table A.4 – Ammonia emission coefficients

	NH_3 emission coefficients
Cultures with fertilizers	*Mg of NH_3 / Mg of N applied / year*
	(cf_i)
Ammonium nitrate	0.02
Ammonium sulphate nitrate	0.05
Ammonium sulphate	0.08
Calcium ammonium nitrate	0.02
Calcium cyanamid	0.02
Calcium nitrate	0.02
Ammonia	0.04
Ammonium phosphate	0.02
Di-ammonium phosphate	0.05
Other complex fertilizers	0.02
Other nitrogenous fertilizers	0.02
Sodium nitrate	0.02
Urea	0.15
Mixed urea and ammonium nitrate	0.08
Animal grazing	*Kg / ha / year*
Permanent grassland	4
Manure management	*Kg / animal /year*
	(mm_k)
Dairy cows	28.5
Other cattle	14.3
Fattening pigs	6.39
Sows	16.43
Sheep	1.34
Goats	1.34
Horses, mules and asses	8
Laying hens	0.37

Source: EMEP/CORINAIR

Table A.5 – Nitric oxide emission coefficients

	NO emission coefficient
Cultures with fertilizers	0.007 Mg of NO / Mg of N applied / year

Source: EMEP/CORINAIR

ANNEX B

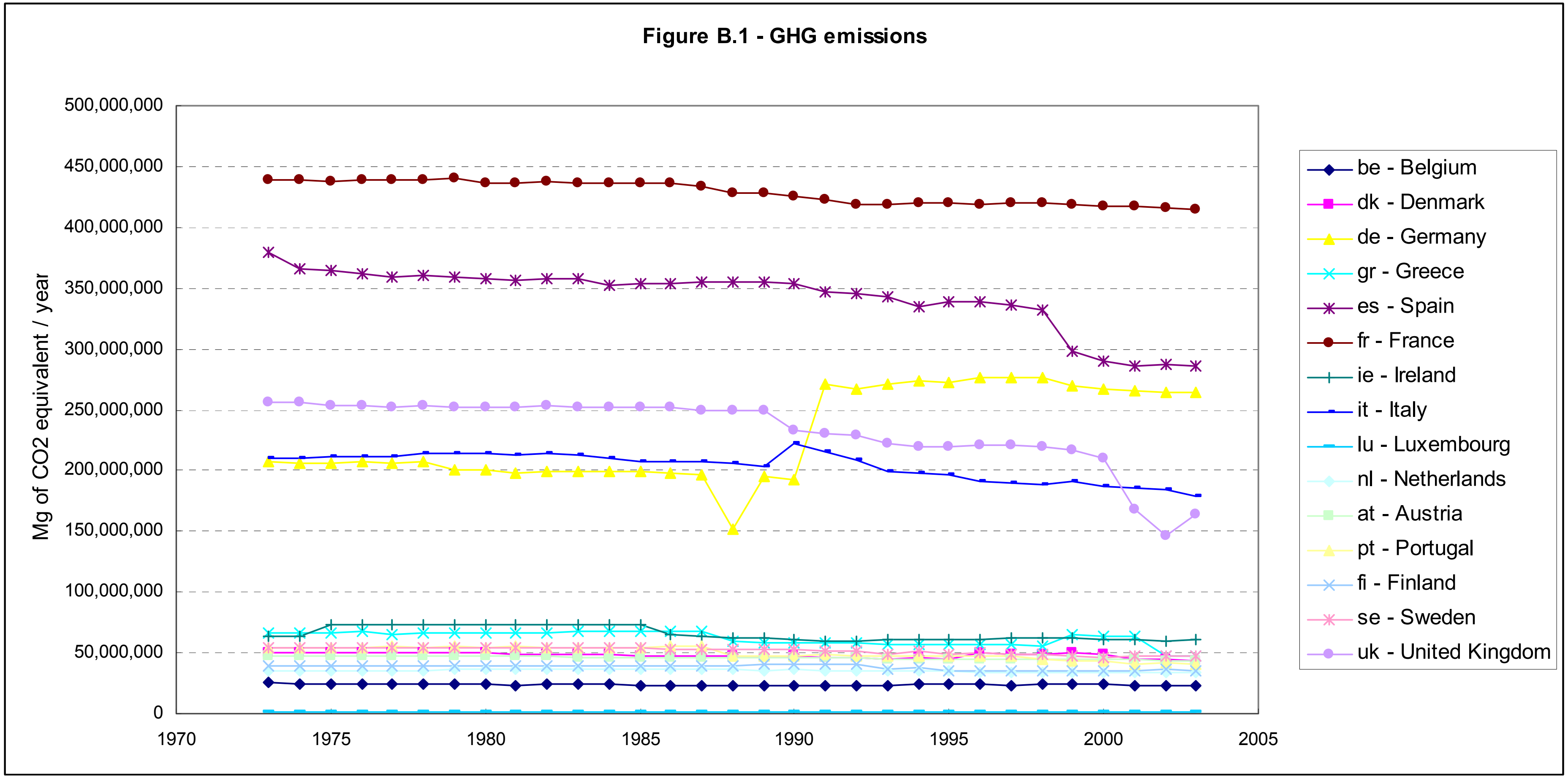
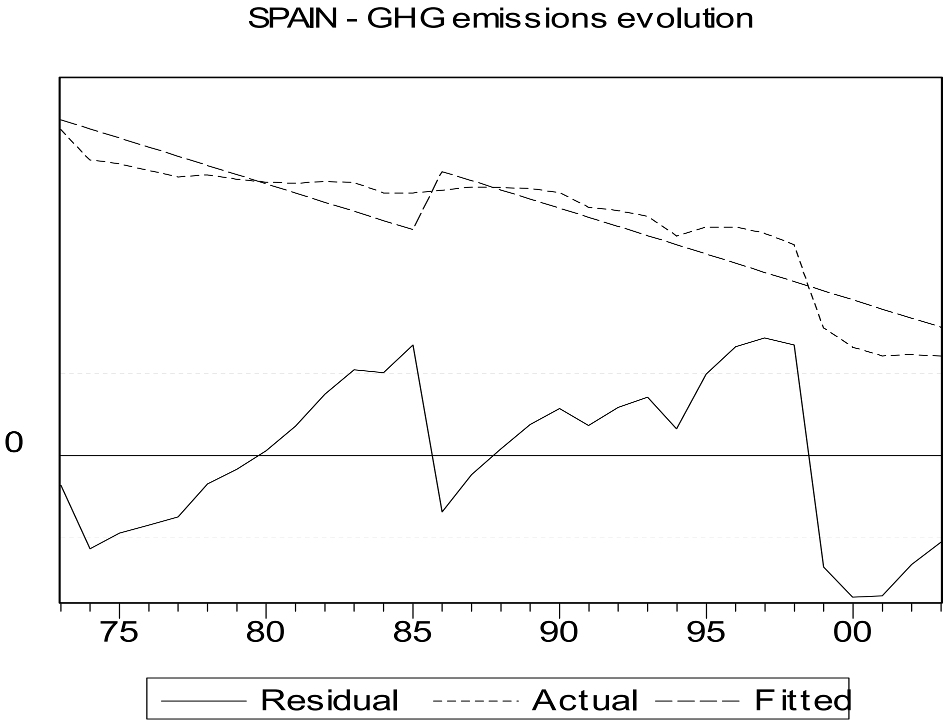


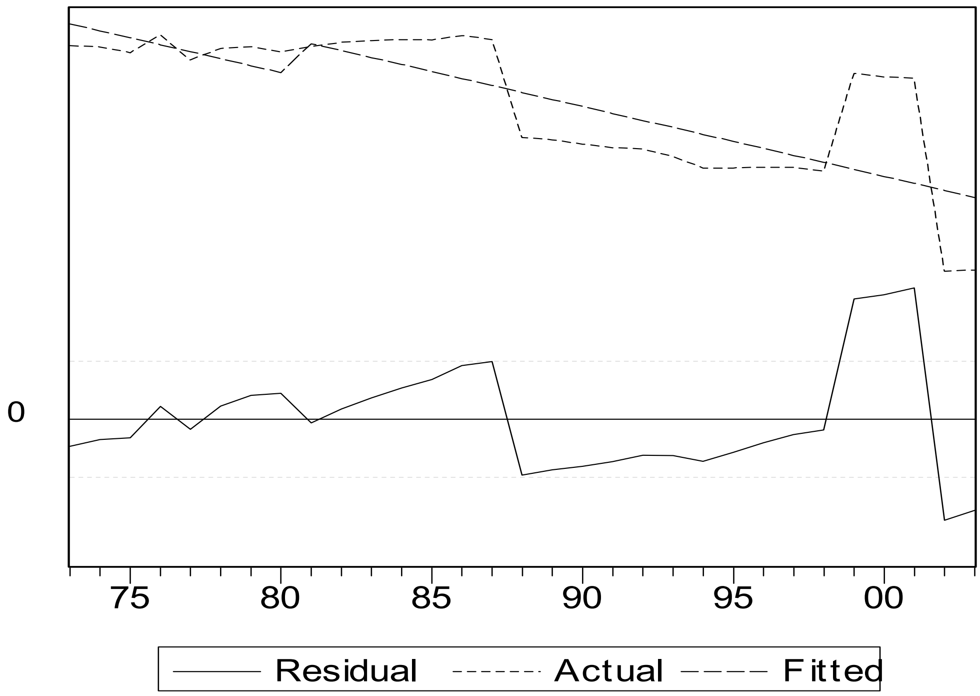
Figure B.1 - GHG emissions
Mg of CO2 equivalent / year
500,000,000
450,000,000
400,000,000
350,000,000
300,000,000
250,000,000
200,000,000
150,000,000
100,000,000
50,000,000
0
1970
1975
1980
1985
1990
1995
2000
2005
be - Belgium
dk - Denmark
de - Germany
gr - Greece
es - Spain
fr - France
ie - Ireland
it - Italy
lu - Luxembourg
nl - Netherlands
at - Austria
pt - Portugal
fi - Finland
se - Sweden
uk - United Kingdom

ANNEX C

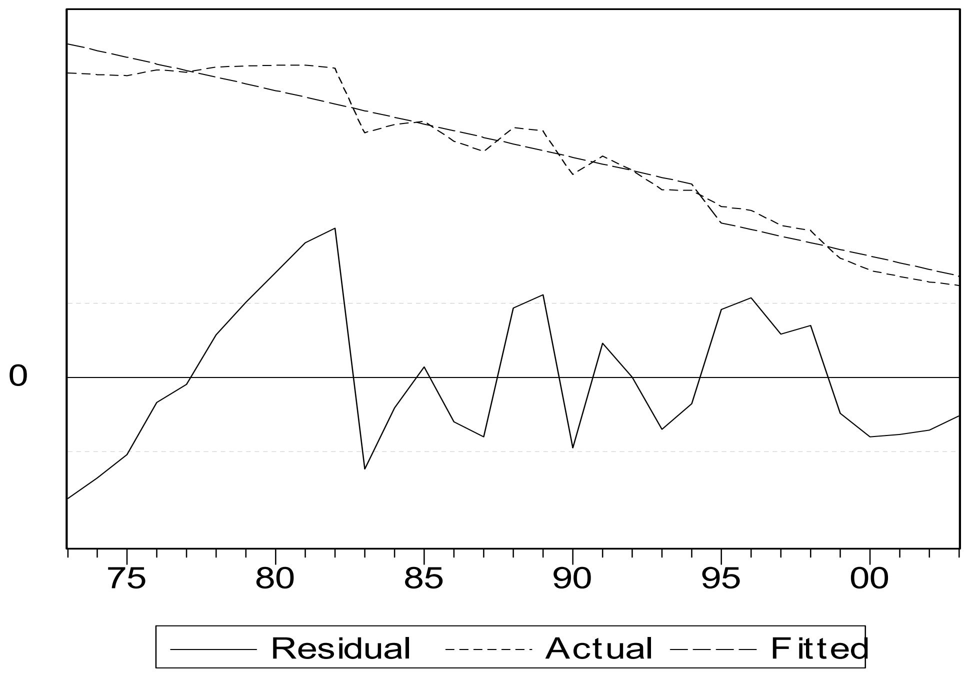


SPAIN - GHG emissions evolution
0
75
80
85
90
95
00
Residual
Actual
Fitted

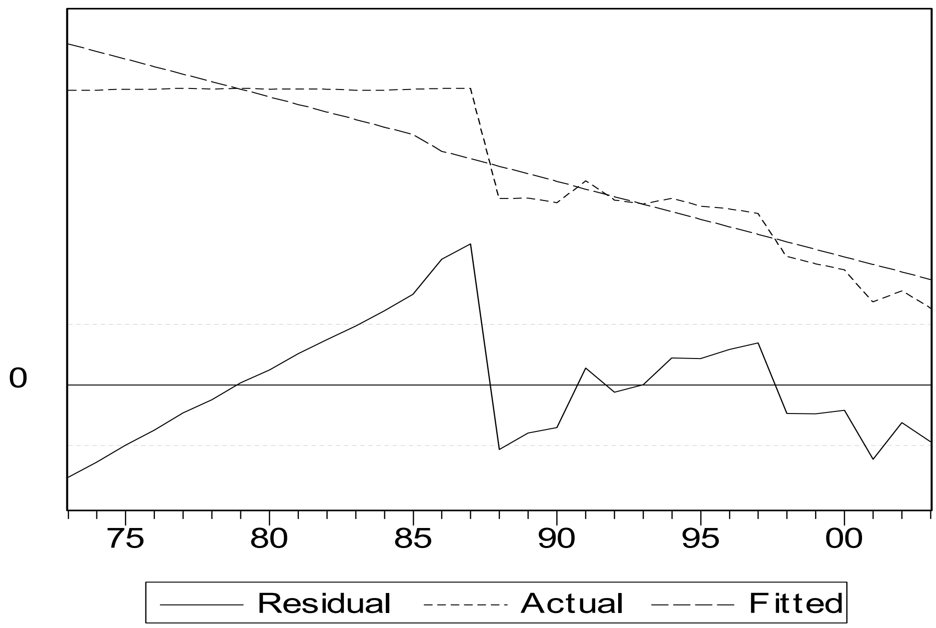
GREECE - GHG emissions evolution



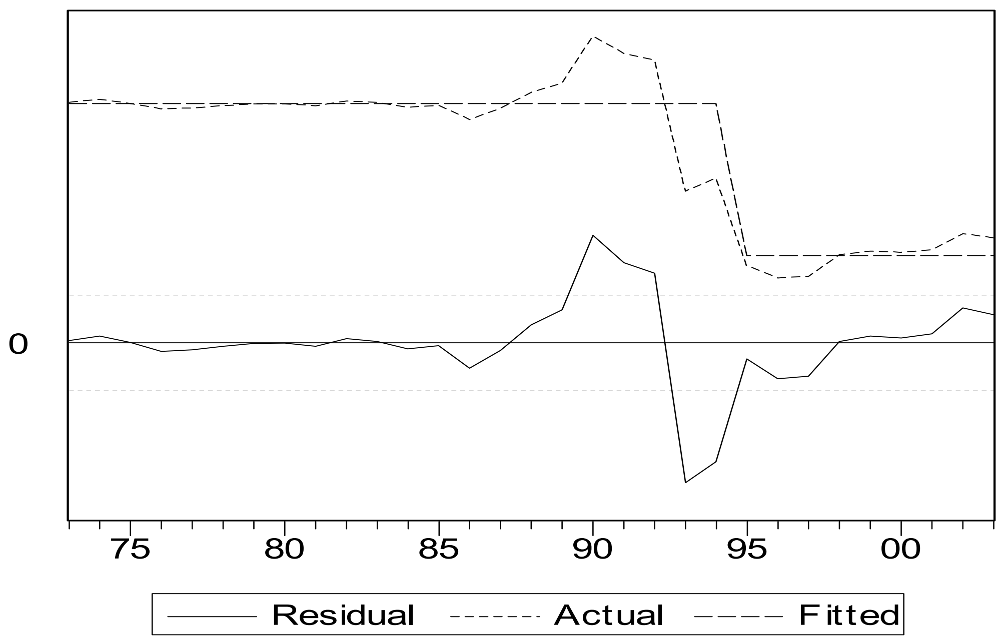
AUSTRIA - GHG emissions evolution



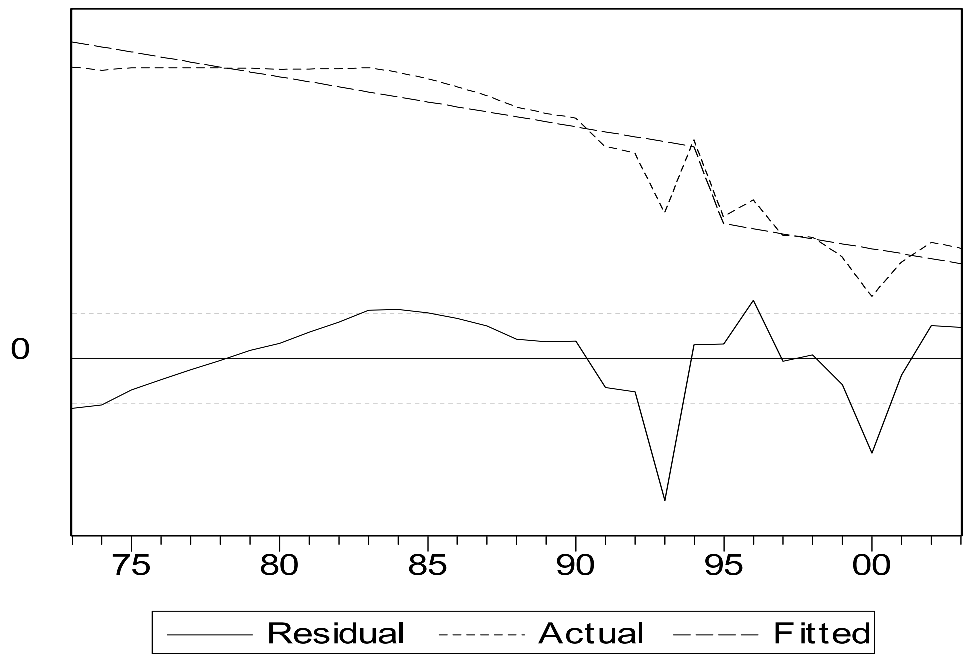
PORTUGAL - GHG emissions evolution



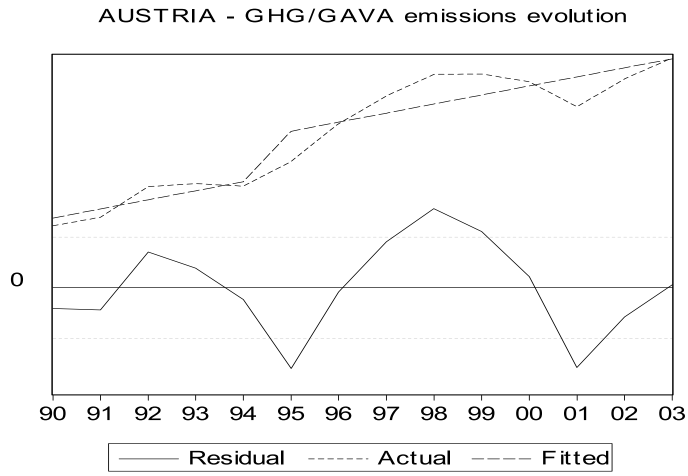
FINLAND - GHG emissions evolution

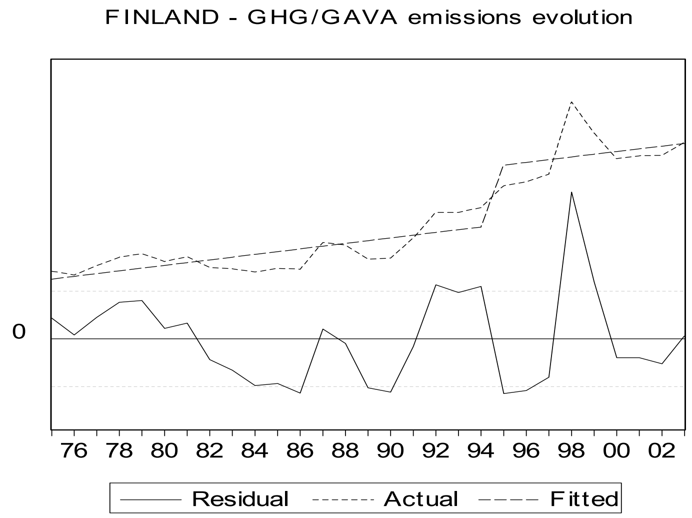


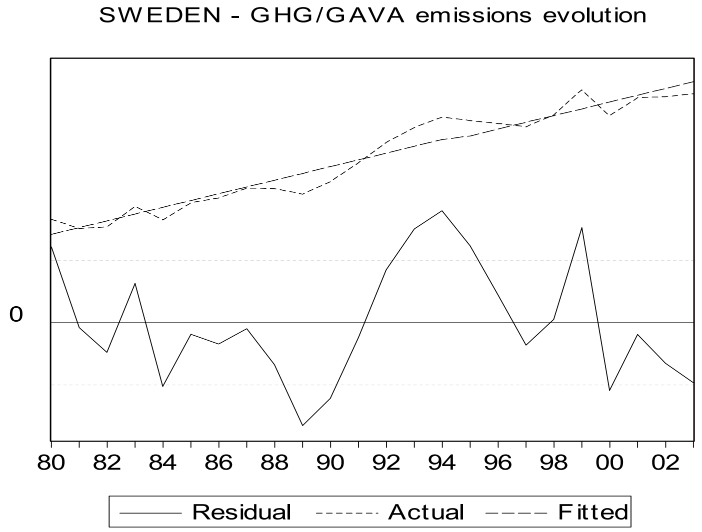
SWEDEN - GHG emissions evolution



ANNEX D


AUSTRIA - GHG/GAVA emissions evolution
0
90 91 92 93 94 95 96 97 98 99 00 01 02 03
Residual
Actual
Fitted


FINLAND - GHG/GAVA emissions evolution
0
76 78 80 82 84 86 88 90 92 94 96 98 00 02
Residual
Actual
Fitted


SWEDEN - GHG/GAVA emissions evolution
0
80 82 84 86 88 90 92 94 96 98 00 02
Residual
Actual
Fitted