Production Effects of Agri-environmental "Green Box" Payments: Empirical Results from the EU

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Abstract

Agri-environmental programs are part of the green box of the GATT Uruguay Round and are supposed to "have no, or at most minimal trade distorting effects or effects on production." In addition, "the amount of payment shall be limited to the extra costs or loss of income involved in complying with the government programme." Utilizing farm accounting data we estimate the effects on yields for ten agri-environmental programs in Austria, which account for 12% of EU's budget expenditures for agri-environmental programs. Only three out of these ten programs have significant negative effects on yields, while one program has a significant positive impact and the rest has no significant impact. These results suggest that there are serious windfall profits associated with some of these programs.

Keywords: Agri-environmental programs, Green box, WTO, Common Agricultural Policy, De-coupling

JEL classification: F16, Q56

1. Introduction

The Uruguay Round Agreement on Agriculture (URAA) in 1994 was the first significant accord towards a more liberalized world trade in agricultural products. The cornerstones of the URAA are: i) market access including tariffication of non-tariff border measures and the subsequent reduction of these tariffs as well as a minimum percentage of imports; ii) export competition including a reduction in the volume of export subsidies and in the quantity of subsidized exports; and iii) a reduction in domestic support, as measured by the Aggregate Measure of Support (AMS) (Moyer and Josling, 2002, chapter 7).

One of the reasons for the limited progress on liberalizing agricultural trade in the seven rounds before the URAA is the importance of domestic policy goals of agricultural policy, including self-sufficiency, "fair" farm income, food security, food quality, rural development, and environmental issues (Blandford and Boisvert, 2002). In the URRA these so-called nontrade concerns[2] were addressed in the "green box".[3] Green box measures are not included in the AMS and therefore exempted from reductions. They must meet the following general criteria: (i) "that they have no, or at most minimal, trade distorting effects or effects on production"; (ii) that "the support in question shall

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[2] It has been argued that these nontrade concerns including EU's reference to the multifunctional role of farming are just a re-airing of the so-called non-economic objectives as discussed in the 1980s (e.g. in Winters,1989) at an early stage of the GATT-Uruguay Round (Anderson, 2000; Potter and Burney, 2002).

[3] The Preamble of the URAA includes an explicit reference to these nontrade concerns; "… commitments under the reform programme should be made in an equitable way among all Members, having regard to non-trade concerns, including food security and the need to protect the environment."

be provided through a publicly funded government programme (including government revenue forgone) not involving transfers from consumer"; and (iii) that "the support in question shall not have the effect of providing price support to consumers" (Annex 2 of the Agreement of Agriculture, signed in Marrakech). Therefore, green box measures are supposed to be fully decoupled payments or what is called a lump-sum transfer.

Although including a multitude of different support measures (e.g. general services like research and extension, domestic food aid, disaster aid)[4] the most prominent and most frequently discussed category of green box payments are agri-environmental programs. In addition, since agriculture is still an important source of environmental degradation (Bromley, 1996, Claassen, 2001) including problems like soil erosion, groundwater contamination, green house gas emission and loss of biodiversity, environmental concerns seem to serve as the perfect example of a legitimate domestic policy objective that might conflict with liberalizing trade. Environmental concerns are also in the center of EU's claim for the multifunctional role of agriculture.

To be accepted as a green box measure agri-environmental programs have to fulfill two additional criteria: (iv) "Eligibility for such payments shall be determined as part of a clearly-defined government environmental or conservation programme and be dependent on the fulfillment of specific conditions under the government programme, including conditions related to production methods or inputs" and (v) "the amount of payment shall be limited to the extra costs or loss of income involved in complying with the government programme" (Annex 2 of the Agreement of Agriculture, signed in Marrakech).

Given this background on agri-environmental policies within the WTO the study at hand examines the production effects of agri-environmental programs in the EU. In particular, we look at the effects on grain yields of ten agri-environmental schemes in Austria. These ten schemes accounted for approximately 12% of EU's expenditures for agri-environmental programs. In addition, in their focus to decrease negative externalities from agricultural production by putting some restrictions on the use of inputs (e.g. on easily soluble commercial fertilizers or pesticides) or requirements on management (codex of good farming practices, organic farming) they are typical for many other agri-environmental programs in the EU, but also in other countries. For example, Diakosavvas (2003) remarks that 68% of agri-environmental programs in the EU are classified in the OECD's Producer Support Measure (PSE) calculations as 'payments based on input constraints.'

In quantifying the production effects of these agri-environmental programs we contribute to evaluate if these programs are in line with the criteria of the URRA, in particular to criteria (i), (iv) and (v). The production effect of an agri-environmental program depends crucially on two things. The first is related to criteria (iv) and the question of what specific conditions related to production methods or inputs have to be fulfilled and to what extend these conditions actually constraint production. Since participation in these programs is voluntary, it has been argued that there is a self-selection bias and farmers receive payments although they do not have to change (or only to a minimal extend) their framing practices (Ahrens et al.). Hence, there would be windfall gains what is not in line with criteria (v). Given that the cost of participation are not equal for all farmers (because of differences in natural and economic conditions), but compensations for participation are usually payments per hectare, windfall gains seem to be inevitable.

The second determinant of the production effect of agri-environmental programs is the extent to which these green payments are decoupled. It has been argued that it is very unlikely that payments that increase income, although not directly connected to production, are actually a lump-sum transfer with no effect on production (Blandford, 2001). Especially, developing countries have contended that developed countries just shifted their farm income support from the amber to the green box (Devadoss, 2002; OECD, 2001a; Neary, 2004). Gohin et al. (2003) and OECD (2001b) discuss theoretically how decoupled direct payments still influence production by having an effect on the decision to stop farming (cross-subsidization), on labor allocation, on investment decisions, and on risk perception. That subsidies are not production neutral is also confirmed by a survey of 459 part-time farmers in eight EU countries which reveals that 85% of all agricultural direct payments are either reinvested or used for operating inputs in the farm holding (Bergström et al. 1998).

[4] See Yumin, Hongxia and Mayu (2004) for details.

However, to date not much empirical work exists on the production effects of agri-environmental programs. Diakosavvas (2003) is doing an ex-post analysis based on observed data. On a more aggregated level with cross-section data of OECD countries Diakosavvas utilizes a meta production function approach and a trade flow equation to measure to what extent agri-environmental policies are production and trade neutral. He finds environmental payments to be small but statistical significant positive determinant of agricultural production and trade. Cooper at al. (2003) conduct an ex-ante analysis for three hypothetical schemes concerned with soil conservation or erosion reduction in the US. They derive effects on exports ranging from -7% to +1%.

The reminder of this study is organized as follows: The next section describes the ten agri-environmental programs in Austria to be analyzed. Section 3 discusses how we use farm accounting data to estimate the production effects of agri-environmental programs. Section 4 represents estimation results and some simulation of the total effect of all ten programss. Section 5 discusses these results.

2. Austrian Agri-environmental programme

The Austrian Agri-environmental Programme OePUL (Austrian programme for the promotion of extensive farming methods compatible with requirements of environmental protection and the maintenance of the countryside) was introduced in 1995, the year after EU-accession consisting of 25 individual schemes (Groier and Loibl, 2000). Here we concentrate our analysis on the ten schemes relevant for grain production:

1.) *Elementary support:* compliance with the code of good fertilising practice; livestock density restricted to 2.5 animal units per hectare
2.) *Organic farming:* in accordance with EU Regulation 2092/91 on organic farming; live-stock density restricted to 2.5 animal units per hectare
3.) *Non-application of agro-chemicals, whole farm:* identical to organic farming in regard to crop production but not animal production; livestock density restricted to 2.5 animal units per hectare
4.) *Crop rotation scheme:* a maximum of 75% of arable land may be cultivated with grains and maize; a winter cover crop covering at least 15% of arable land must be planted; direct payments increase with the share of arable land covered by winter crops
5.) *Extensive grain (wheat, barley, oats, rye) production:* grain cultivation limited to low-yield varieties; non-application of growth regulators or fungicides; crop specific limits of N-fertiliser application; non-application of sewage sludge; maintaining of the grassland area
6.) *Non-application of growth regulators*
7.) *Non-application of easily soluble mineral fertilisers and growth regulators*
8.) *Non-application of easily soluble mineral fertilisers and synthetic chemical crop protection agents*
9.) *Non-application of fungicides*
10.) *Non-application of synthetic chemical crop protection agents*

The first four schemes require the farm to participate with the whole area, while the rest allows for partial participation (e.g., that only 15% of a farm's tilled acreage are managed according to a scheme's regulations). Since Organic farming and non-application of agro-chemicals at the whole farm have basically the same requirements for crop production we will put them in the same category in the empirical analysis.

In 1997 these ten schemes accounted for about 68% of total expenditures for agri-environmental programmes in Austria (Groier and Hofer, 2002). In the same year about 21% of total EU budget for agri-environmental programmes was transferred to Austria. Hence, these ten schemes accounted for about 12% of all EU's expenditures for agri-environmental programmes.

The considered schemes are quite typical for agri-environmental programs. According to Diakosavvas (2003) 68% of all agri-environmental programs in the EU and more than 60% in the OECD are measures restricting the use of specific inputs.

3. Data and Method

To estimate the production effects of these ten schemes farm accounting data linked with the official agricultural support data (INVEKOS) for a sample of 1327 Austrian farms was available. We had two years of observation before the introduction of these agri-environmental programs (1993, 1994) and two years with these programs in place (1997, 1998). In estimating the production effects we face two main problems: i) farmers can participate in more than one programme at the same time (Table 1) and ii) that participation rates were highly unequal between schemes (Table 2).

Table 1: Distribution of farmers in the sample regarding to the number of participations in agri-environmental schemes

participation in	**Number of farms**
no scheme	45
1 scheme	50
2 schemes	199
3 schemes	629
4 schemes	431
5 schemes	31
6 schemes	1

Table 2: Number and percentage of participants for a sample of 1327 bookkeeping farms

scheme	**absolute**	**%**
Elementary support	1244	93.7
Organic farming	154	11.6
Non-application agro-chemicals, whole farm	33	2.5
Crop rotation scheme	1141	86.0
Extensive grain production	511	38.5
Non-application growth regulators	823	62.0
Non- appl. chemical fertilisers & growth regulators	35	2.6
Non- appl. chem. fertilisers & synth. crop prot. agents	24	1.8
Non-application fungicides	83	6.3
Non-application synthetic crop protection agents	12	0.9

In order to be able to compare yields of different kinds of grain (wheat, rye, oats, barley) we construct an index of relative yields. In addition, this formulation enables a nice interpretation of the regression results later on and makes it unnecessary to account for technical progress over time. The relative yield of farm *i* for grain *j* (v_i^j) is given by

$$v_i^j = \frac{V_i^j}{\bar{V}^j}\ , \quad i = 1, \ldots, n \text{ farms, and } j = \textit{wheat, rye, barley, oats}, \tag{1}$$

where V_i^j is the absolute yield of farm *i* for grain *j* and $\bar{V}^j$ is the average yield for grain *j* over all *n* farms. The relative yield of farm *i* over all *j* grains (v_i) is given by

$$v_i = \frac{\sum_j \left(v_i^j F_i^j \right)}{\sum_j F_i^j} \quad , \quad \text{i = 1, . . . , n farms, and j = wheat, rye, barley, oats,} \qquad (2)$$

where F_i^j is the area farm *i* allocates to grain *j*. Hence, v_i is the weighted average of the relative yields of all grains.

Since participation in agri-environmental programs is voluntary there is obviously a self-selection bias problem. Therefore, it is important to account for the different natural and economic conditions of the farms. It is helpful to have information about the farms even before the introduction of the agri-environmental program and we utilize this information in two different econometric models: i) fixed-effects, and ii) difference-in-difference.

In the fixed-effects approach relative yields of farm *i* in the year *t* ($v_{i,t}$) are explained by a vector $\boldsymbol{X}$ of natural (soil, climate, weather, …) and economic factors (farm size, specialisation, management, …), other unobserved farm specific factors $\boldsymbol{\alpha_i}$ and a dummy vector $\boldsymbol{D}$ of program participation.

$$v_{i,t} = \boldsymbol{\alpha_i} + \boldsymbol{\beta_i} \boldsymbol{X_{i,t}} + \gamma_i \boldsymbol{D_{i,t}} + \varepsilon_{i,t} \qquad (3)$$

where ε_i is a random error term. For schemes including the whole farm $\boldsymbol{D_{i,t}}$ is set to 1 if a farm participated in a specific year and 0 for non-participation. For schemes including only specific crop areas $\boldsymbol{D_{i,t}}$ is set to the ratio between participating and total crop area. A parameter value of $\gamma 1 = -0.07$ would imply a 7% lower yield for participation on average.

In the difference-in-differences approach we compare the situation before the introduction of the agri-environmental program (an average of 1993 and 1994) to the situation afterwards (an average of 1997 and 1998):

$$\left(v_{i,1997/98} - v_{i,1993/94} \right) = \alpha + \boldsymbol{\beta'_i} \left(\boldsymbol{X_{i,1997/98}} - \boldsymbol{X_{i,1993/94}} \right) + \boldsymbol{\gamma_i} \boldsymbol{D_{i,t}} + \boldsymbol{\delta_i} \boldsymbol{R_i} + \varepsilon_{i,t} \qquad (4)$$

where α is a constant. In addition to the observed farm specific factors $\boldsymbol{X_i}$, and the participation dummies $\boldsymbol{D_i}$, we include a vector of dummies $\boldsymbol{R_i}$ for the production area in which the farm is located (Since this doesn't vary over time we can not include these dummies in the fixed-effects model.) Again a parameter value of $\gamma 1 = -0.07$ can be interpreted as a 7% lower yield for participation.

4. Results

To describe the different economic and natural conditions of farmers as represented by vector $\boldsymbol{X}$ we use

AREA: tilled area

RATIO: the ratio of tilled to total farm area

UVH: unit value per hectare: this is a variable compiled for tax purposes including soil characteristics, climate etc.

AUH: animal-units per hectare

In the fixed effects model the expected sign of the coefficient of AREA is positive, since relative yields are expected to increase with farms size. This variable accounts for economies of scale. The same positive sign is expected for RATIO (yields improve with specialisation) and UVH (yields

improve with better soil and climatically conditions). If the yields will improve with an increasing AUH is not completely clear. On the one side farms with more animal units per hectare might be those specializing in animal production not crop production. On the other side more AUH implies more manure. In the case of the difference-in-difference model positive and negative signs for the differences in AREA, RATIO, UVH and AUH are possible. Vector $\boldsymbol{R_i}$ consists of dummies for 89 different production regions (Kleinproduktionsgebiete) in Austria as defined in Schwackhöfer (1996) and Wagner (1990a, 1990b).

Table 3: Results of fixed-effects model

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	0.153	0.025	6.173	0.000
Elementary support	0.012	0.015	0.808	0.419
Organ. farm. & non-appl. agro-chem., whole farm	-0.076	0.017	-4.533	0.000
Crop rotation scheme	0.022	0.013	1.674	0.094
Extensive grain production	-0.079	0.017	-4.727	0.000
Non-application growth regulators	0.004	0.014	0.300	0.764
Non- appl. chemical fertilisers & growth regulators	-0.031	0.043	-0.721	0.471
Non- appl. chem. fertilisers & synth. crop prot. agents	0.062	0.085	0.730	0.466
Non-application fungicides	-0.017	0.054	-0.314	0.754
Non-application synthetic crop protection agents	-0.089	0.103	-0.862	0.389
AREA	-0.001	0.001	-1.659	0.097
RATIO	0.100	0.047	2.160	0.031
UVH	0.633	0.032	19.658	0.000
AUH	0.083	0.014	5.920	0.000
Adjusted R-squared	0.685			

Results of the fixed-effects are illustrated in Table 3. Since Organic farming and non-application of agro-chemicals at the whole farm have basically the same requirements for crop production we put them in the same category. The explanatory variables RATIO, UVH and AUH are significant at least at the 5% level. The variable AREA is significant at the 10% level, but has the wrong sign. RATIO, UVH. Only three of the ten participation dummies are significant at least at the 10% level: organic faming and application of agr-chemicals at the whole farm, crop rotation, and extensive grain production. On average, participation in organic farming decreases yields by about 7.6%. Participating in the crop rotation program has a positive effect on yields of 2.2% and extensive grain production decreases yields by 7.9 percent. The R^2 is satisfactory with 0.69.

Results of the difference-in-difference models are illustrated in Table 4 and 5. Since there ares some farms who participate in programs in 1998, but not 1997 we compare the average of 1993 and 1994 either to 1997 (Table 4) or to 1998 (Table 5). The results in Table 5 are not very different from the results of the fixed-effects model. The same three programs have a significant impact on yields in at a comparable level. If we compare the average of 1993 and 1994 to 1997 (Table 4) only organic farming has a significant impact. However, 1997 was an abnormal year with quite high average yields and a much lower variance. With 0.22 and 0.21 the R^2s are satisfactory for a difference-in-difference estimation. The regional dummies are highly significant as revealed by an F-test.

Table 4: Results of difference-in difference model, average 1993 and 1994 to 1997

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.003	0.057	-0.058	0.954
Elementary support	0.031	0.023	1.307	0.191
Organ. farm. & non-appl. agro-chem., whole farm	-0.072	0.022	-3.339	0.001
Crop rotation scheme	0.022	0.017	1.302	0.193
Extensive grain production	-0.037	0.026	-1.395	0.163
Non-application growth regulators	-0.019	0.017	-1.113	0.266
Non- appl. chemical fertilisers & growth regulators	-0.061	0.051	-1.190	0.234
Non- appl. chem. fertilisers & synth. crop prot. agents	-0.083	0.113	-0.734	0.463
Non-application fungicides	-0.061	0.064	-0.962	0.336
Non-application synthetic crop protection agents	-0.081	0.115	-0.698	0.485
AREA	-0.001	0.001	-1.270	0.204
RATIO	-0.082	0.078	-1.059	0.290
UVH	-0.081	0.131	-0.620	0.536
AUH	0.061	0.022	2.776	0.006
Adjusted R-squared	0.220			

Table 5: Results of difference-in difference model, average 1993 and 1994 to 1999

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.166	0.058	-2.833	0.005
Elementary support	0.006	0.024	0.254	0.800
Organ. farm. & non-appl. agro-chem., whole farm	-0.066	0.022	-3.000	0.003
Crop rotation scheme	0.032	0.017	1.846	0.065
Extensive grain production	-0.052	0.026	-2.029	0.043
Non-application growth regulators	-0.018	0.018	-0.997	0.319
Non- appl. chemical fertilisers & growth regulators	-0.052	0.052	-1.005	0.315
Non- appl. chem. fertilisers & synth. crop prot. agents	0.047	0.106	0.442	0.659
Non-application fungicides	-0.060	0.065	-0.924	0.356
Non-application synthetic crop protection agents	-0.080	0.117	-0.683	0.495
AREA	-0.002	0.001	-2.588	0.010
RATIO	-0.208	0.073	-2.863	0.004
UVH	-0.134	0.113	-1.187	0.235
AUH	0.039	0.019	1.996	0.046
Regional Dummies				0.000
Adjusted R-squared	0.210			

Since farmer can participate in more than one program and almost all participate in the two big programs elementary support and crop rotation, one can see all ten programs as a package and ask for the overall effect of these ten programs. To answer this question we conduct some simulation experiment. Starting from the coefficients and standard deviations estimated in the regression analysis we randomly draw one value out of the underlying normal distribution for each coefficient and weight it with the percentage of farmers of the sample participating in each program. Adding up the results for all ten programs gives the overall effect of all ten programs. Repeating this procedure 10,000 times gives a mean effect as well as a standard deviation. The results of this simulation exercise for all three underlying regression models are illustrated in Table 6. The overall effect is estimated to be close to zero (between -1.1% and 0.2%) on average. However, given the uncertainty of the regression estimates of some program effects (high standard deviations of participation dummies) the possible overall impact has also a quite high standard deviation. In 50% of the simulated cases the overall effect is between -13% and +11% based on the fixed-effects model.

Table 6: Overall effects of agri-environmental programs

program	fixed-effects	diff-in-diff 93/94-97	diff-in-diff 93/94-98
Elementary support	0.012	0.028	0.007
Organ. farm. & non-appl. agro-chem., whole farm	-0.010	-0.010	-0.010
Crop rotation scheme	0.019	0.018	0.027
Extensive grain production	-0.030	-0.014	-0.020
Non-application growth regulators	0.003	-0.011	-0.010
Non- appl. chemical fertilisers & growth regulators	-0.001	-0.002	-0.001
Non- appl. chem. fertilisers & synth. crop prot. agents	0.001	-0.002	0.001
Non-application fungicides	-0.001	-0.004	-0.004
Non-application synthetic crop protection agents	-0.001	-0.001	-0.001
Sum	-0.008	0.002	-0.011
Standard deviation	0.176	0.211	0.212
50% Intervall lower	-0.126	-0.141	-0.155
50% Intervall upper	0.111	0.145	0.132

5. Discussion

On 1 August 2004 in Geneva the 147 members of the WTO agreed on a framework for modalities to liberalize farm trade. An important result is that though domestic support will further be reduced green-box payments will remain untouched. Agri-environmental programs are on group of policies under the Green box and have to fulfill several criteria including (i) “that they have no, or at most minimal, trade distorting effects or effects on production”, that (iv) “Eligibility for such payments shall be determined as part of a clearly-defined government environmental or conservation programme and be dependent on the fulfillment of specific conditions under the government programme, including conditions related to production methods or inputs” and that (v) “the amount of payment shall be limited to the extra costs or loss of income involved in complying with the government programme” (Annex 2 of the Agreement of Agriculture, signed in Marrakech). This study empirically measures the production effects of ten agri-environmental programs in Austria. These ten programs account for 12% of EU expenditures for agri-environmental programs. In addition these programs are typical for the largest class of EU agri-environmental programs, those trying to reduce negative externalities of production by limiting some of environmental harmful inputs. Participation is voluntary and farmers are compensated by fixed area payments.

Our estimates can confirm negative effects of program participation on yields for three out of the ten programs: one is organic farming, a second is equal to organic farming in regard to crop production only, and the last one is extensive grain cultivation (including a limitation to low-yield varieties; non-application of growth regulators or fungicides; crop specific limits of N-fertiliser application; non-application of sewage sludge; maintaining of the grassland area). One program (crop rotation) has a significant positive effect on production, and one program (elementary support) has a positive, but insignificant effect. For all other programs participation has a negative effect which is also not significant. Given this, and some simulation on the overall effect of all ten programs, it seems that these programs are more or less in line with criteria (i) of the URAA “that they have no, or at most minimal, trade distorting effects or effects on production”. However, since most programs have no significant negative effect on yields and one program has even a positive effect, it seems that there is a serious self-selection bias (i.e. farmers participate only in those programs where they don’t have to change their behavior) creating serious windfall profits. This seems to be not in line with criteria (v) “the amount of payment shall be limited to the extra costs or loss of income involved in complying with the government programme.” To avoid this windfall profits, payments have to be linked to the cost of participation what is not the case for most programs to date. In the long run the approval of

these payments in trade negotiations as well as by society in general will crucially depend on the extent these programmes actually internalise externalities rather than creating rents to farmers.

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