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JACEK KULAWIK
Institute of Agricultural and Food Economics
– National Research Institute
Warsaw

SELECTED FINANCIAL ASPECTS OF AGRI-ENVIRONMENTAL PROGRAMMES

Abstract

Agri-environmental programmes should be designed, implemented and evaluated on the basis of the use of the scientifi output of new welfare economics, and in particular to its part define as the cost-benefi analysis. Then, there is a chance that the public goods and inter-nalised externalities offered by the farmers will be optimised. Subsequently, it will be pos-sible to properly defin the increase in total costs and the effects occurring in the farms that choose to participate in the available agri-environmental projects. This means that the rates of payments to farmers for agri-environmental services will be calculated on an objectifie basis. In a larger scope, it will be possible then to rely on the diversity of rates of remunera-tion of farmers. This way, it will be possible to improve cost and allocation efficienc of the programmes themselves and to streamline public expenditure incurred on the agri-environ-mental policy and to reduce the welfare losses caused by taxation.

Keywords: agri-environmental programmes, cost-benefit analysis, Pigovian subsidy, competiveness, greening, direct payments.

Introduction

Welfare economics, which is a sub-discipline of neoclassical economics, is the main theoretical basis for environmental analyses. Modern welfare economics, also called new welfare economics, builds on over 100 years of accomplishments of neoclassical, psychological and mathematical schools. In its theoretical, model and application aspects it tries to integrate the theory of externalities and public goods, social choice and general optimisation, as well as the cost and benefit analysis. At the lower level, welfare economics uses well-known microeconomic categories (consumer theory and consumer surplus, producer theory and producer surplus, various competition and utility models, as well as welfare models), macroeconomic categories (general equilibrium theory) and terms from the sphere of economic policy (social welfare optimum, public finance theory). Contract design issues link welfare economics with the management theory, in particular with the agency theory, economic information theory and game theory. Externalities and public goods constitute the basis for modern environmental and natural resource economics. The above shows that agri-environmental issues form a complex system of various interdependencies, which have not been fully investigated and require interdisciplinary knowledge, experience and effective economic and ecological models to analyse them, perform simulations and improve policy tools aimed at achieving the assumed objectives.

Basics of cost-benefit analysis

Cost-benefit analysis (CBA) has an important place in modern welfare economics. There are numerous definitions of the above type of developed microeconomic account. Their common feature is that the account consists of a set of techniques to facilitate the choice of solutions, projects and undertakings preferred by the society, which consume rare resources and have complex impacts (effects) which often emerge only in the long term and are not easily measured in money. CBA reduced to environmental issues is usually called the socioeconomical account. Every CBA scheme refers to tri-element procedure where all important components of quantitative measurement should be identified first and then presented in commonly used natural units, i.e. quantified, and finally indexed, i.e. expressed in value measure of their total. In practice, the above scheme is extended to include explicit specification of costs and benefits, their time distribution (discounting), cost and benefit transformation into cash flows and their reduction to net present value (NPV), performance of resilience and sensitivity tests and accounting for risks.

Identification and quantification of environmental elements and environmental services in socioeconomical account is very problematic, but their indexation is by far the most difficult [17, 40]. It may be performed statically or dynamically [3]. The main objective of static indexation is to obtain total environmental value (TEV). The authors obviously differ in terms of what the components of this total value should be. Some include alternative, existing (potential) and actual (practical, pragmatic) value of resources [3, 9, 14]. However, a more often used term is the utility value of the environment, resulting from its direct or indirect exploitation and the non-utility value in the form of e.g. value of options (time shift of the resource use time), inheritance values (transfer of a part of resources to next generations), or existence value (value of a resource as such) [16, 21, 41]. Dynamic indexation focuses on measurement of ecosystem services themselves, i.e. on the value of benefit flows from environmental resources. Both types of indexation require appropriate valuation and appraisal tools. Figure 1 presents an interesting, comprehensive and modern view on this very complex issue. When constructing remuneration rates for farmers for provision of agri-environmental services, it would be very advisable to refer to those theoretical and methodological foundations.

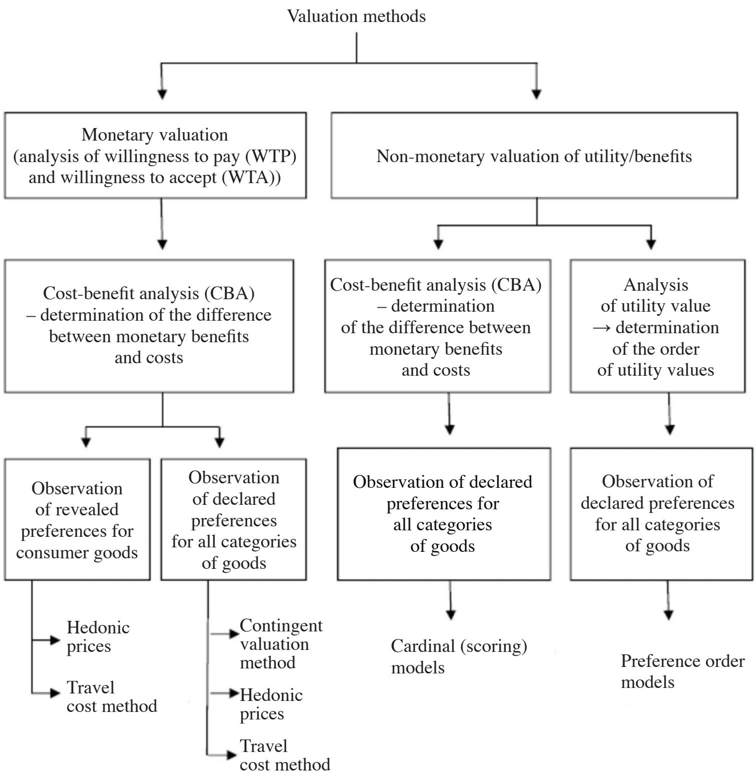
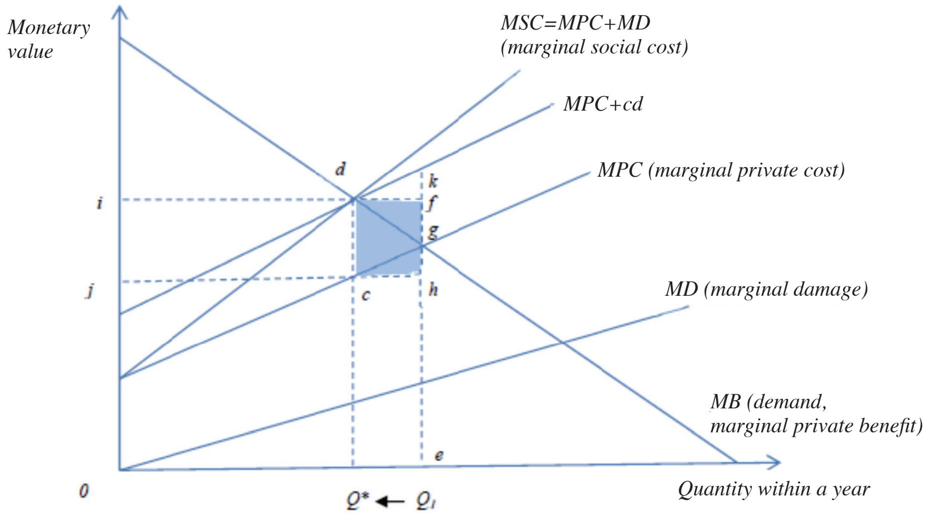


Fig. 1. Classification of valuation methods of non-marketed goods.
Source: own elaboration based on [25].

The concept of Pigovian subsidy (also called Pigovian tax) should serve as the theoretical basis for remunerating the EU farmers for provision of public goods and internalisation of externalities. It is worth reminding that this British economist presented the outline of his concept in 1912 and published its complete version in 1920. The essence of the Pigovian subsidy is presented on Figure 2.



Key: cd – subsidy per final unit of product *Q*.

Fig. 2. Negative externality – its internationalisation using the Pigovian subsidy.

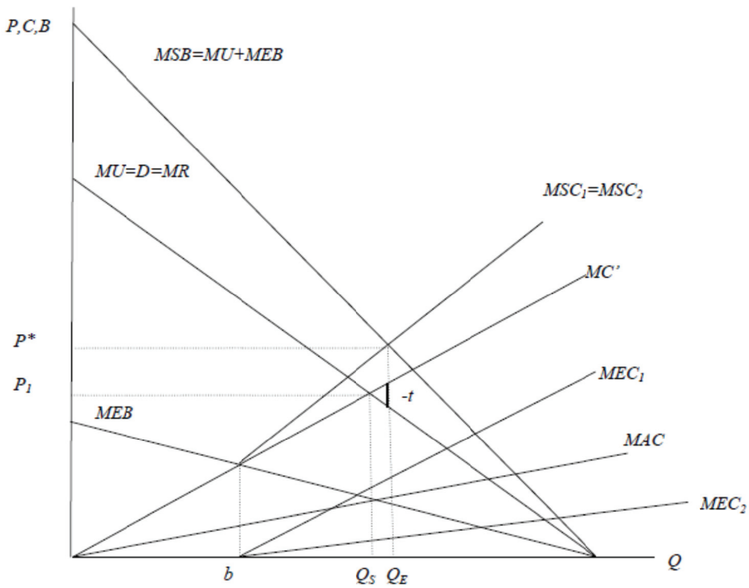
Source: own elaboration based on [33].

A. Graczyk and K. Kociszewski introduced an interesting modification to the standard Pigovian subsidy (see Fig. 3) [17]. It consists in including in the geometrical interpretation of the problem the consequences of implementing the cross-compliance (*CC*) principles in the *EU* agriculture. Before the modification, unit payment per 1 ha could be calculated as a difference between a marginal social benefit (*MSB*) and demand for agricultural production (*MU*). However, after taking into account *CC* its value decreases to the difference between *MU* and *MC*', i.e. the total of marginal private cost of production and marginal abatement cost. Nevertheless, the lower payment rate is still sufficient for the farmer to approach the social optimum (point Q_E), where the volume of externality is justified economically.

In practise, the exact application of the Pigovian subsidy principles presents many difficulties. The major ones are as follows:

– The perpetrators of externalities must be explicitly identified and cannot be too many. In other words, the problem must be precisely diagnosed and described at the very beginning;
– Externalities must be measured in money;
– There is no mechanism automatically guaranteeing the achievement of Pareto optimum. To approach the optimum, subsidy rates should be diversified, i.e. adjusted to the costs of emerging externalities. This requires the establishment of a well-functioning monitoring system. However, the regulator (public institution) will as a rule have considerable problems gathering very detailed information;

– Subsidies may not be advisable for ethical and moral reasons;
– An active role of the state is required which, however, may transform into excessive intervention and the easiest solutions;
– The instrument is asymmetrical which leads to redistribution of income and assets in a way that is not always justified and socially acceptable, and sometimes to eliminate some producers in the sector, when external cost optimum required reduction of harmful emissions [3, 9, 25, 33]. The Pigovian tax and subsidy are usually related to moderate administration and transaction costs and offer an opportunity to align private and social costs of internalisation of externalities.



Key:
MAC – marginal abatement cost,
MC – marginal private cost of production,
MC' – total of *MC* and *MAC*,
MEB – marginal external benefit,
MEC – marginal external cost,
MSC – marginal social cost of production,
MU – marginal utility of a consumer.

Fig. 3. Internalisation of external benefits by means of subsidies linked with the requirement to meet obligatory environmental standards.

Source: own elaboration based on [17].

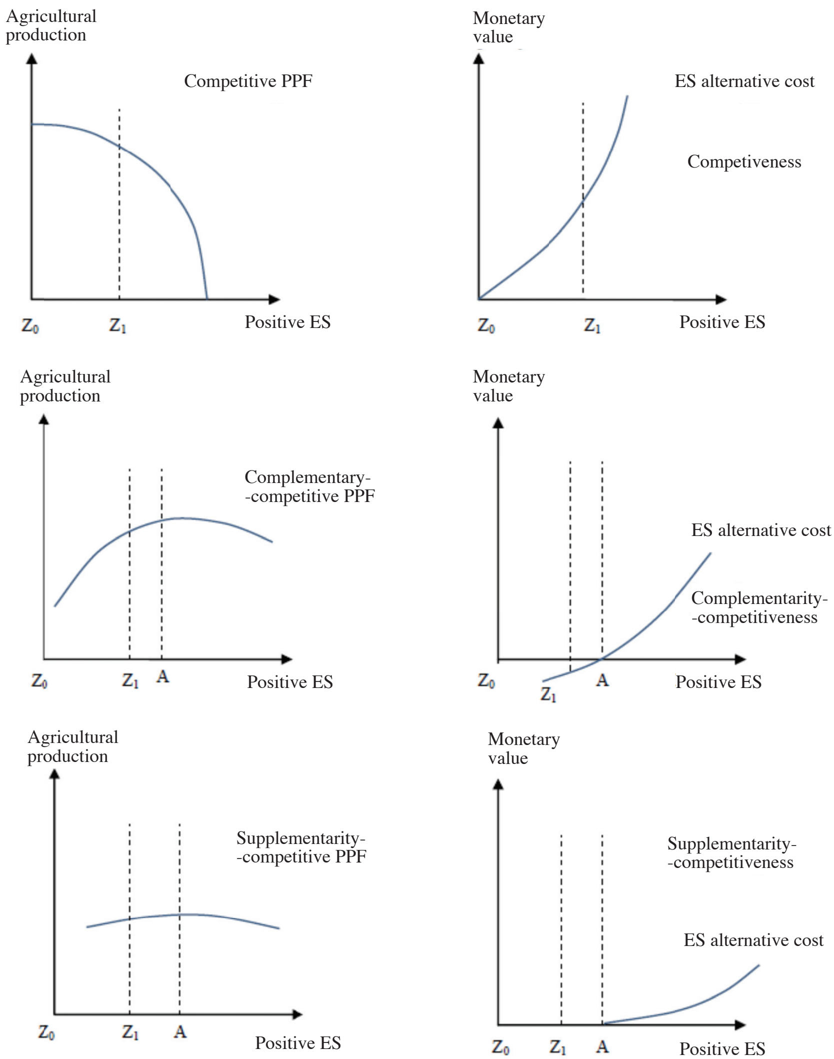
Costs and effects in agri-environmental programmes

In the above programmes, marginal costs should, as a rule, be applied in differential terms. This has been stressed by a group of eminent experts in this area [13, 15, 22,]. Recently the problem has been thoroughly analysed by J. Sauer and A. Wossink [34]. The essence of their analysis is presented on Figure 4. The starting point of their deliberations is a well-documented fact that the majority of agri-environmental services are coupled with production of traditional/market agricultural products. It is most often cheaper than separate provision of agri-environmental services. Thus, the problem should be analysed in terms of relations between a traditional product and an agri-environmental service or their package. Three types of relations are possible:

a) Competitive, i.e. increased production of one product results in a decrease in supply of other product (upper panel on Fig. 4);
b) Complementary, if the produced quantities of both products increase within certain frontiers. In the middle panel, A is the frontier;
c) Supplementary, i.e. the increasing quantity of one product does not result in reducing the offered quantity of other product within a wide range. In the bottom panel, it is the quantity of agri-environmental services determined by section Z_0 - A.

The relations are very often mixed. In the said figure, Z_0 means the level of agri-environmental services meeting cross-compliance requirements (*CC*), point Z1 is the reduction of the quantity of offered agri-environmental services, while A means the level from which agri-environmental services make a positive contribution to market goods production. The right part of Figure 4 shows alternative costs of agri-environmental services which constitute the focus of Sauer and Wossink's analyses. After numerous calculations, the authors reach e.g. an obvious conclusion that marginal analysis is necessary for regional differentiation of agri-environmental payment rates and their targeting until they reach the rates determined based on an auction system. This creates the potential allowing to improve cost effectiveness of agri-environmental programmes and prevents payment of excessive compensation to some farmers. In turn, this enables more effective use of public funds, but at the same time generates, at least in the first stage, higher administration and transaction costs.

In recent years, more and more publications question cost effectiveness of agri-environmental projects [23, 24]. This is undoubtedly due to their complexity and multiple objectives, but it also reflects information asymmetry between contracting institutions (e.g. Agency for Restructuring and Modernisation of Agriculture) and farmers. The latter are definitely better informed. In consequence, agri-environmental programmes often involve negative selection, moral hazard, opportunism of farmers and behaviour described as fare dodging. In such conditions, it is very difficult to calculate the agri-environmental payment rates which would be perfectly aligned with costs incurred by farmers and agri-environmental effects they obtain. In other words, some farmers receive excessive subsidies, while others obtain insufficient ones, which translates into their low motivation and reluctance to get involved in voluntary agri-environmental undertakings. In such situations, public spending is not optimal and welfare losses increase due to taxation for agri-environmental policy purposes.



Note: definitions of letter symbols are in the text.

Fig. 4. Agricultural production possibility frontier (PPF) and environmental services (ES) and their alternative cost.

Source: own elaboration based on [34].

A very interesting explanation of the issue of adequate subsidies for farmers for provision of public goods and internalisation of externalities was provided by S. Chabé-Ferret and J. Subervie [8]. It is synthetically presented in Figure 5. It shows the agricultural land actually covered by agri-environmental obligation (continuous line) and counterfactual area, i.e. potential, non-actual area, which reflects the fact that some farmers would behave as if they implemented a given projects of this type (dashed line). Two effects follow: an additional effect, i.e. type of value added resulting from the performance of the above-mentioned obligation, and a windfall effect, i.e. type of extraordinary, unexpected income. According to this logic, farmers should be entitled to remuneration from the budget only for additional effects. The above reasoning can of course be applied to other bases for calculating agri-environmental payments than area. In practice, all countries where agri-environmental programmes are in place experience considerable differences with defining and measuring additional effects. Chabé-Ferret and Subervie explain it mainly with complexity of identification of the nature and direction of causality. The additional effect, also called casual, is based on counterfactual area, which in fact is not empirically observed, but estimated.

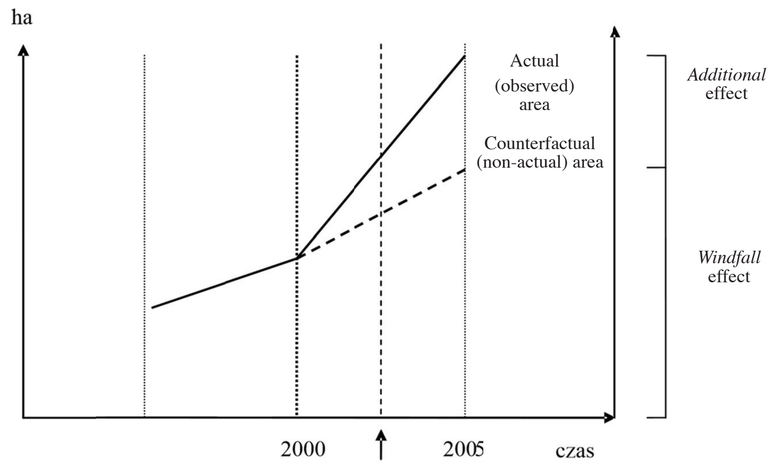


Fig. 5. Additional and windfall effects in agri-environmental programmes (AEP).
Source: own elaboration based on [8].

The estimation of the latter suffers from two types of econometric bias:
- time trend bias, resulting from the comparison of the farmer's behaviour before accession to the programme and after accepting an agri-environmental commitment. Moreover, practices applied by the farmer may change, even if the farmer did not participate in the programme;
- due to differences in comparison of farms participating in a given programme and operating outside the programme (selection bias).

Figure 6 presents the method of identification of the above biases and additional effects. Determination of the causality direction remains a fundamental problem of econometric analyses. However, there are several methods to obtain relatively satisfactory results. They include, first of all, the following techniques:
– matching estimators;
– difference-in-difference (DID);
– instrumental variables (IV);
– regression discontinuity design (RDD);
– randomised control trials (RCT) [7, 8, 18].

Researchers calculating agri-environmental payment rates should have a good knowledge of highly advanced econometric tools. The problem is that Poland suffers from the lack of such highly qualified specialists.

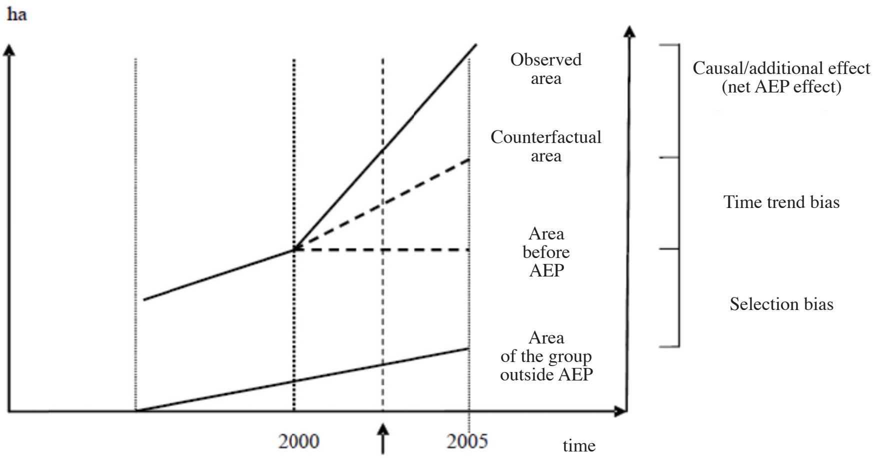
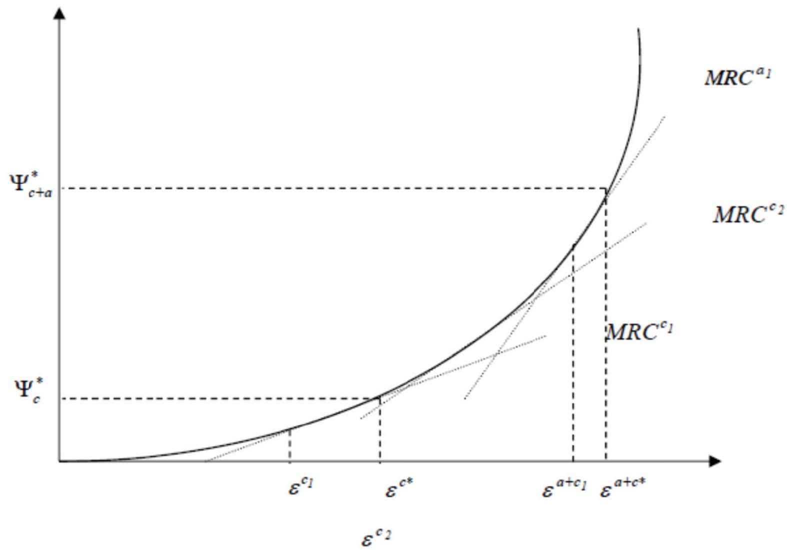


Fig. 6. Econometric bias in agri-environmental programmes (AEP).
Source: as in Fig. 5.

As earlier mentioned, costs and payments in agri-environmental schemes must be analysed in close relation with biases resulting from the obligation to observe the cross-compliance principles, and thus with direct payments. Cross-compliance is to be a baseline, i.e. the border between environmental costs and benefits and the border between protection of natural resources and increasing their value. Therefore, in purely theoretical terms, the commitment level corresponding to *CC* is tantamount to applying the "polluter pays" principle. In practice it means that *CC* costs entitle to direct payments in the full amount. The failure to observe *CC* entails sanctions in the form of subsidy reduction. The problem is how to balance the sanctions and enforce them efficiently[1]. Environmental

[1] In the United Kingdom, for example, approximately 5% of farmers do not observe *CC*, since they do not consider the sanctions to be very acute and hoping that the government monitoring will not detect this fact [12].

commitments exceeding the *CC* level should thus be additionally rewarded in line with "the provider gets" principle. This philosophy is one of distinguishing features of agri-environmental payments. Since the costs of adjustment due to *CC* concern the entire farm and fixed costs of agri-environmental programmes are similar, their amount is subject to degressivity when the scale of agricultural activity increases. In other words, the fixed component of total compliance costs decreases per unit of the subsidy total in the form of direct payments and agri-environmental payments within a wide range of a growth of the farm size. This factor largely explains why in Poland economically stronger farms participate in agri-environmental programmes more often than small ones, despite the preferences for the latter in the form of modulation of agri-environmental payments [26]. Therefore, the above suggests that larger farms may be excessively subsidized, achieving the earlier described windfall effect.



Key:

ε^{c1}, ε^{c2} – current levels of public good provided by the farmer,
ε^{c*} – level of public good compliant with cross-compliance requirements (*CC*),
ε^{a+c*} – level of public good contracted in the agri-environmental programme (agri-environmental commitment),
Ψ – functions of costs of *CC* observance and the agri-environmental programme,
MRC – various levels of marginal revenue resulting from increasing compliance of the farmer with agri-environmental commitments and CC principles.

Fig. 7. Costs of observance of obligatory cross-compliance (CC) standards and agri-environmental programmes (AES, AEP).

Source: own elaboration based on [2].

As stated earlier, agri-environmental programmes are subject to asymmetry of information, and thus with an advantage of farmers over the contracting authority. This results in negative selection and moral hazard, complicating the structure of contracts and sanctions for non-compliance and increasing the monitoring costs. Italian researches modelled the problem in a very interesting way [2]. Fig. 7 will prove helpful here. It presents various amounts of agri-environmental commitments on the horizontal axis, and marginal costs and revenue on the vertical axis. It is a very simplified and stylised method of presenting the problem which was formally presented in the text and extended to include four types of farmer profit functions and variables affected by the policy and from the area of public choice and monitoring. Graphic and formal analysis is supplemented with numerical procedure of solving the formulated optimisation problems.

Calculation of agri-environmental payments

The most popular method of calculating agri-environmental payments is the differential approach, also called the incremental approach. It is a static approach, since it does not account for changes in the value of money over time[2]. The complete calculation formula looks as follows:

$$PR\acute{S}_b + PP = WI + KE + KA \tag{1}$$

where:

$PR\acute{S}_b$ – gross agri-environmental payment;

PP – other benefits, i.e. cost decreases and/or revenue increases;

WI – investment expenditure/outlays which for practical reasons should be averaged, i.e. their amount should be divided by the number of years of agri-environmental commitment;

KE – operating/production/current costs; this item also includes transaction costs;

KA – opportunity costs.

The formula (1) must be met for every year of the agri-environmental programme and for "organic farming" measure. It is, thus, clear that the annual agri-environmental payment is the difference:

$$PR\acute{S}_b = (WI + KE + KA) - PP \tag{2}$$

Some problems may occur with including the *PP* element, but it may be important under the "organic farming" measure due to higher prices which may more than offset the lower harvest and yield. The calculation of opportunity costs presents an even greater challenge. It is commonly assumed that they constitute

[2] This technique is, first of all, applied to the so-called protective undertakings in environmental management of all organisations and in the environmental policy. More information about the subject is available in [11, 14, 16, 21, 38].

remuneration for extensification of a previously intensive farm. This may happen in a short period, but not necessarily in the long run. More reliable research would be advisable. The earlier quoted publication by Sauer and Wossink proves that the function of opportunity costs may have varied forms and course. The complexity of interdependencies in agri-environmental programmes is demonstrated e.g. in the research by J. Busenkell and E. Berg [6]. It shows that participation in the programme of "protection against erosion on arable land" resulted in a growth of income, but also in its increased variance. In the programme entitled "farming for protection of the environment" the profitability improved the most at the poorest land. Ecological indicators proved to be equally important and better. However, it must be added that Busenkell and Berg had extensive data resources to estimate various functions of production and costs and to model and simulate the behaviour of economic and environmental factors.

From the point of view of budget spending, Busenkell and Berg obtained a similar result to that of Glebe, i.e. that synergy effects should be achieved based on the existing agri-environmental programmes [15]. It means that the potential differentiation of those programmes does not have to entail a surge of budget spending at the stage of their implementation, but its increase may be expected at the stage of supervision and monitoring. A. Pufahl and Ch.R. Weiss also reached some very interesting, but also surprising conclusions [31]. They established that German farms participating in agri-environmental programmes with payments exceeding EUR 100 per 1 ha recorded an increase in expenditure for plant protection (also per 1 ha) by 46.2% compared to the control group, i.e. facilities not covered by such programmes. This may be due to employing technologies maintaining crop cultivation or increased intensification of agricultural land not covered by the programme(s). It is very alarming and little is known of its effective prevention. However, the resulting recommendation for evaluators and researchers of the above programmes is to analyse the behaviour of the entire farm and, in parallel, its main economic and environmental factors. Another option to be considered is to reduce agri-environmental undertakings addressing narrowly defined problems, if it is impossible to precisely determine the explicitly measurable targets to be achieved.

Since farmers must expect payment reduction, if they fail to comply with the contract conditions, the net payment amount may be lower. Thus a simple formula:

$$PR\acute{S}_n = PR\acute{S}_b - S \tag{3}$$

where:
$PR\acute{S}_n$ – net agri-environmental payment,
S – financial sanctions[3].

[3] Apart from the earlier mentioned article by F. Bartolini et al., the problem is also extensively discussed in [30, 36, 41].

If a given agri-environmental measure or the "organic farming" measure is to be equivalent in terms of greening of the CAP first pillar, the above formulas must ignore the costs and potential investment expenditure related to cross-compliance requirements.

Agri-environmental programmes and organic farming may also be treated as a type of projects/investments. If changes in money over time are included in the latter evaluations, we will receive dynamic presentation of payments for the above services. Net present value (NPV) will then be the best analytic category. Assuming that the analysed measures will be implemented on farms for five years, formula (1) will read as follows:

$$NPV = \sum_{t=1}^{5} PR\acute{S}_{bt} \frac{1}{(1+r)^t} + \sum_{t=1}^{5} PP_t \frac{1}{(1+r)^t} - \sum_{t=1}^{5} WI_t \frac{1}{(1+r)^t} - \sum_{t=1}^{5} KE_t \frac{1}{(1+r)^t} - \sum_{t=1}^{5} KA_t \frac{1}{(1+r)^t} \quad (4)$$

where:
r – discount rate.

The discount rate for a farmer will be the weighted average cost of capital used in a given undertaking, and thus it will include the interest on own and foreign capital and the proportions between the two types of financing. In the case of a contracting authority, such as the Agency for Restructuring and Modernisation of Agriculture, a social discount rate should be used. However, the problem is that there is no generally accepted formula to determine this rate. Interestingly, its numerical value may be both positive and negative, as well as it may equal zero, depending on the society's preferences with regard to the present and the past. Therefore, in practice its value is usually socio-political [3, 4, 10, 14, 19, 32, 39]. The estimation of the social discount rate allows to calculate the environmental present value of the undertaking/project/programme. M. Foltyn-Zarychta denotes it with the acronym ENPV [14]. The category includes non-environmental net social benefits and net environmental benefits. One of distinguishing features of this approach is the need to adjust net cash flows by price deformation effects resulting from the exchange of costs/benefits on an effective (adjustment equal to zero) or non-effective (adjustment different than zero) market. In other words, dual/shadow prices must be included.

In the case of NPV, a farmer decides to "enter" an agri-environmental programme, if the value is above zero. Therefore, if PPt is omitted in formula (4), the above decision rule would mean that the discounted sum of payments should exceed the discounted sum of expenditure and costs. Such result may be obtained for various time distributions of cash flows on a farm. This would constitute a significant obstacle in contracting, since both the farmer and the contracting authority would have to very meticulously plan those flows every year. Therefore, the payments could also change year by year. To ensure applicability of formula (4), a simplifying assumption must be made that in each year of the contract with the farmer the payment would be equal, but slightly higher than the total of investment expenditure and operating and opportunity costs. It would have to be higher so that NPV would be above zero each year and thus would automatically mean the requirement over the entire five years. In financial mathematics, such problems are often solved using average proceeds and average expenditure, i.e. the so-called annuities [1, 5, 25, 35]. Formula (4) should obviously be adequately transformed, with discounting, to obtain net payments and for variants equivalent to greening. The dynamic approach could probably improve the effectiveness of budget spending, but would be difficult to implement in our agriculture. Realistically, the NPV concept could be applied most quickly in the case of individually determined rates of agri-environmental payments, that is e.g. in the auction system. Auctions are an attempt to mimic the market of external effects and to internalise them by means of using the Coase theorem which in turn provides the basis for creating the markets of disposable rights to emit pollutants (Emissions Trading Schemes, ETS). Attempts to organise such markets have appeared also in agriculture recently[4].

Summary

Agri-environmental programmes have been a part of the EU agricultural policy since 1992, i.e. the beginning of the MacSharry reform, while their equivalents appeared later in the USA and other OECD countries. In theory, this instrument is aimed at achieving the improvement of the condition of the environment beyond the requirements of the direct payment scheme. This objective is to be accomplished by changing the behaviour of farmers, reducing the intensity of farming and achieving specific environmental indicators. Participation in such programmes is voluntary and thus the difficulties in estimating all additional costs incurred by farmers due to participation and actual benefits obtained by the society. The consequences include mounting problems with adequate remuneration for farmers for the provided public goods and internalisation of externalities. Some farmers receive excessively high compensation, in particular in rather unfavourable areas, while those who pursue farming in good conditions are insufficiently motivated to carry out agri-environmental undertakings. The situation will further deteriorate under the new EU budget perspective, where greening of direct payments will become another instrument of agri-environmental policy. In such conditions, methods of regional differentiation and application of individual calculations of agri-environmental payments should become increasingly important.

[4] The literature describes experience with trading in rights to appropriate quality water [27, 37]. The Dutch experience with trading in pollution caused by using mineral fertilizers is also very interesting [20, 28]. Meanwhile, Italians experiment with rights to carbon sequestration [29].

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