CONSOLE

CONtract Solutions for Effective and lasting delivery of agri-environmental-climate public goods by EU agriculture and forestry

Research and Innovation action: H2020 - GA 817949

Deliverable D3.1
The participation of farmers in innovative contract solutions based on secondary data analyses (M34)

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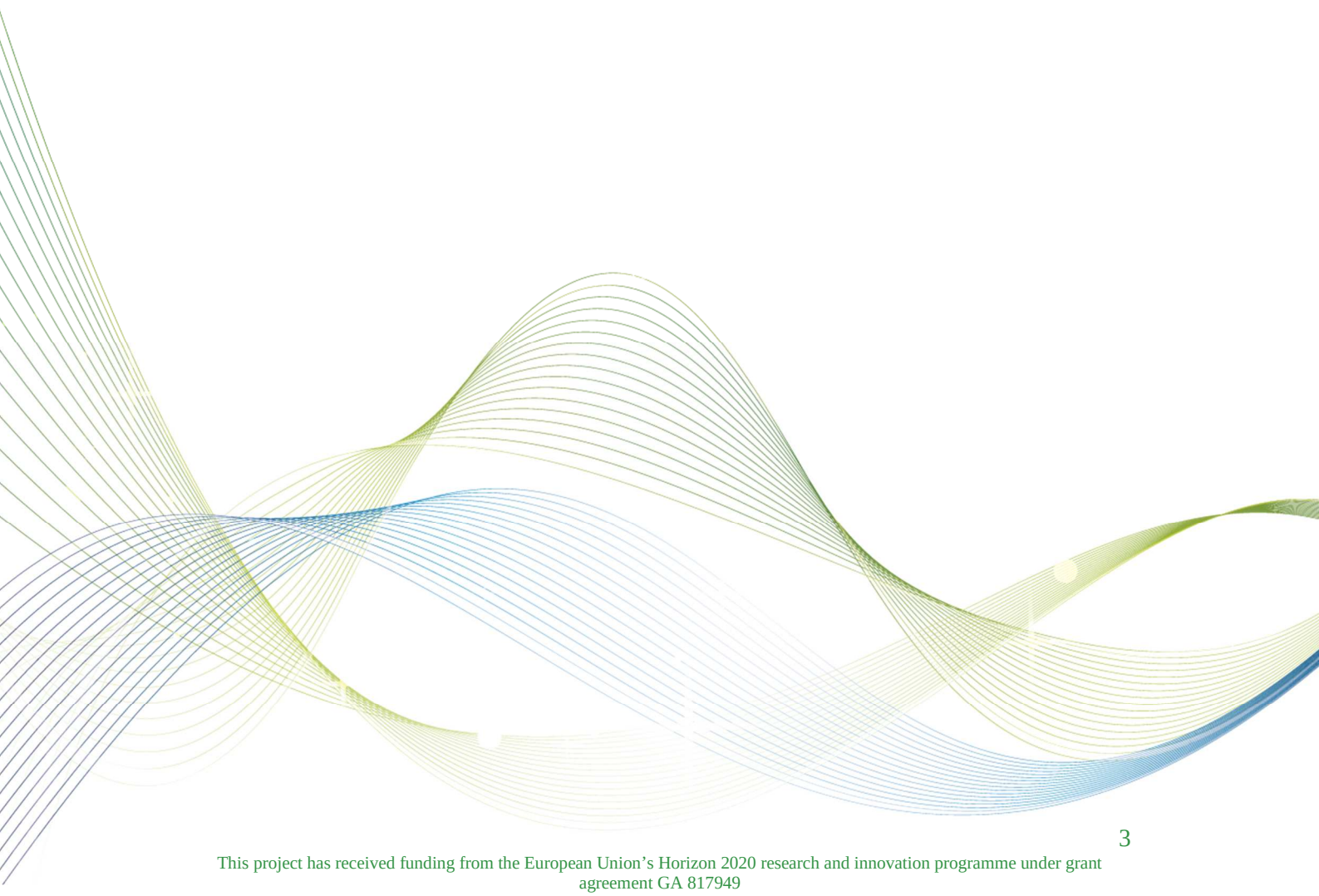

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Table of contents

CONSOLE 2
1 Summary 7
1.1 Scope of Task 3.1: Analysis of secondary data 7
1.2 Deliverable outline 7
2 Availability of secondary data 7
2.1 Investigating the data availability 8
2.2 Using open-access secondary data 8
2.3 Going further: the need of restricted-access data 9
2.4 Adding primary data to the mix 9
3 Analysis of secondary data 9
4 Secondary analysis to investigate cost and governance features 10
4.1.1 France: Cost of changing dairy cows' diet to reduce enteric methane emissions in livestock farms. 10
4.1.2 Finland: Participation and renewal of private forest owners' fixed-term forest biodiversity contracts in Finland 11
4.2 Secondary analysis to estimate adoption drivers of innovative contractual solutions 16
4.2.1 Italy: Identification of compliance costs estimates 16
4.2.2 France: An econometric methodology to model contracts uptake applied with the Farm Accountancy Data Network 18
4.2.3 Italy: A systematic review of attributes used in choice experiments for agri-environmental contracts 20
5 General insights 21
5.1 Replicability of data usage 21
5.2 Of the use of secondary data to analyse AECPG contract solutions and modelling 21
6 Acknowledgment 22
7 References 22

List of Figures

Figure 1. The area (ha) of new contracts agreed each year during the years (1997-2020) (left axis) and the cumulative area (ha) of valid contracts (right axis). Picture published in Hänninen et al. 2021 13
Figure 2. Forest owners' satisfaction with the contract renewal decision on a scale of -3 (very dissatisfied) to +3 (very satisfied). 15
Figure 3. Distribution of rent in the hill and mountain area of the province of Bologna, including forest and uncultivated land (panel A) and excluding forest and uncultivated land (panel B) (rent in euro/ha; cumulated area in hectares). 17

List of Tables

Table 1. Summary of results of selected studies 17

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement GA 817949

Table 2. Descriptive statistics of the sample. 19

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1 Summary

1.1 Scope of Task 3.1: Analysis of secondary data

The work carried out in this task is related to objective O.3.1 "To assess variables affecting farmers's behaviour through secondary data".

Secondary data analyses are useful to understand ex-post the participation of farmers in innovative contract solutions and then to assess the expected supply of the targeted public goods (PGs). This is important to assess the possibilities of PG demand and supply matching. Moreover, analysis of secondary data may provide strategic information about the consequences of innovative contracts in terms of commodity production changes, farm labour/land/input demand changes and some environmental side effects. These are pieces of information always requested by public authorities, especially local ones since production often means labour demand in local downstream industry. They are also requested by private organizations willing to finance payments for environmental services (PES), e.g. carbon sequestration, to communicate on the bundle of PGs they pay for. The participation of CONSOLE partner teams in secondary data analysis first depends on the availability of relevant data in their country or Case Study Region (CSR). Innovative contract indicators must correspond to the data base variables or data base variables should be good proxies of the relevant indicators governing the innovative contracts. Where sufficient information is available, it is expected to retrieve these data and to analyse them using econometric tools, in order to estimate ex-post features affecting supply of agri-environmental climate public goods (AECPGs) and the effect of policy design, location and selection criteria on this supply.

The work carried out in the period has focused on understanding the availability of secondary data and in discussing the role they could have in the project. In particular, attention has been focused on the contribution they could give to WP4 in terms of e.g. cost, that could support model implementation. The works has followed different pathways depending on local availability and conditions.

1.2 Deliverable outline

In this deliverable for task 3.1., we first discuss which type of available data the different research teams have used to conducts their studies. Then, we present in more details the results obtained from these secondary data following to main purposes: (1) investigate the cost and governance features to scale up a particular innovative contractual solution and (2) estimate the adoption drivers of innovative contractual solutions. Finally, we propose a short discussion regarding the replicability of the dataset construction process and use.

2 Availability of secondary data

The material used for the analysis of secondary data are of two types:

- Open-access data - coming from administrative data sets, such as the anonymized farm accountancy data network (FADN) supplemented by aggregated data of agricultural and economic statistics;

- Restricted-access data – either coming from public data set but requiring administrative authorization to access more specific and detailed data (panel data on individual farms included

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in the Farm Accountancy Data Network – FADN); or coming from private datasets from private structures.

In both case, legal issues can erase, associated to the General Data Protection Regulation.

A first of the analysis of the secondary data is to investigate the availability of such data and how they can be used to assess variables affecting farmers' behaviour.

2.1 Investigating the data availability

When assessing data availability, UNIBO has explored three options. The first is related to the availability of data from the Emilia-Romagna regional administration about participation in agro-environmental schemes (AES). This has been done though two dedicated meetings. The potential data available have been identified according to extraction procedure already used during the SPARD project (fp7). In addition, national RICA information already available from CREA-PB has been explored. RICA data are the basic data used for feeding FADN commitments. Finally potential data from previous projects, in particular PROVIDE have been re-examined. It will be likely possible to proceed with these data when the modelling approach will be clarified in the WP4 tasks. After screening this information, rather than pointing at participation data, it has been decided to focus on elaborations of available data at regional and country level to analyse: a) variability and distribution of opportunity costs from AECPG uptake; b) any available literature that estimates costs of relevant AECPG measures in Emilia-Romagna (and close regions in Italy). This will allow to support modelling in WP4 for contracts types where heterogeneity among farmers is key to understand participation and likely performance of new contract solutions as compared to traditional (practice based) contracts; this refers in particular to result based contracts and the relationships between contracts and land tenure.

2.2 Using open-access secondary data

Regarding the CAP agro-environmental and climate measures (AECM) and organic farming (OF) measures implemented in France, INRAE developed an econometric specification to simultaneously estimate the adoption probability and the minimal acceptable payments of these measures by each FADN farm. This econometric methodology is designed to enable WP4 simulations of different CAP reform scenarios, such as the increase in expenditures of AECM/OF measures, the changes in coupled and/or decoupled payments or changes in farmland rents for targeted farms, by innovative land tenure schemes for instance. New empirical results are established about the interplay between the different CAP measures and take into account farm characteristics and location. However the FADN does not distinguish innovative AECM, like WP2 FR5, from usual ones. Present efforts are devoted to add the CAP administrative information on AECM contracts to FADN observations.

INRAE has also explored a balanced panel of 735 French FADN dairy farms for the years 2016 to 2018 from summer to winter 2020 to discuss case-study FR4 (Eco-Methane program). In this result-based contract solution, the payment is calculated according to the reduced units of enteric emissions of a farm in comparison with the baseline of its corresponding production system scenario (same region and fodder system). The baseline emissions were obtained from the association implementing Eco-Methane. The FADN data on location and fodder crops enabled the computation of the 11 Eco-Methane references and the characterization of every FADN dairy farm with baseline emissions. These data were used to assess 2 variables affecting farmers'

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behaviour and contract effectiveness with a result-based payment: (i) the choice of environmental indicator capturing the effect of farmers' practices (ii) the payment amount relative to the extra costs incurred (Fanny Le Gloux et al. 2021, see section 3). The elaborated methodology can be adapted to other result-based contractual solutions.

2.3 Going further: the need of restricted-access data

To go further into their analysis regarding the study case, the INRAE team needed more detailed data. In spring 2021, the association coordinating the Eco-Methane program shared secondary data on the participants collected between 2016 and 2020. They include individual information on their enteric methane emissions measured over the years, and their location and fodder system when they entered the scheme. The INRAE is still discussing with the association to see how it would be possible to collect additional necessary data (evolution of fodder crop rotations over the years) from the 600 farmers already involved in the program, to estimate the methane reduction of various changes in fodder crop rotation. The Eco-Methane example shows that associating accountancy data with the appropriate data to compute the relevant environmental result indicator is crucial.

2.4 Adding primary data to the mix

To conduct their study (Hänninen et al. 2021), Luke received existing register data from Forestry Centre on fixed ten-year key forest habitat protection agreements that ended in 2014-2018. To explain and understand the register data, it was supplemented with survey information from the private forest owners whose temporary voluntary contracts terminated in the aforementioned period.

3 Analysis of secondary data

Once the access to data granted, the results and achievements obtained came from three investigation strategies:

(1) The first strategy is to use secondary data to investigate the cost and governance features to scale up a particular innovative contractual solution. It is implemented by INRAE for Green House Gas (GHG) Abatement in dairy farms with a result based payment. In the study conducted by LUKE, secondary data and the survey data supporting it were collected and studied to examine the changes in regulation, how the process regarding the potential renewal of terminated agreements was functioning and the effects these changes have induced among private forest owners' preferences and behaviour for biodiversity enhancement in forest.

(2) The second strategy is based on large secondary data sets to estimate the adoption drivers of innovative contractual solutions. It is implemented by INRAE and (partially) UNIBO with National and Regional FADN data. INRAE provided a methodology to enable WP4 simulations of different CAP reform scenarios, such as the increase in expenditures of AECM/OF measures, the changes in coupled and/or decoupled payments or changes in farmland rents for targeted farms, by innovative land tenure schemes for instance.

(3) The third, implemented by UNIBO, is to collect data from published studies to provide information about compliance costs and their distribution in view of WP4. UNIBO has also conducted a meta-analysis to analyse the attributes used in choice experiments for agri-

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environmental contracts and determine which are critical for farmers' participation in agri-environmental schemes (see Raina et al. 2021).

4 Secondary analysis to investigate cost and governance features

4.1.1 France: Cost of changing dairy cows' diet to reduce enteric methane emissions in livestock farms.

4.1.1.1 Background and objective

Introducing fodder with high omega 3 content such as grass or linseed in the feed ration of dairy cows both improves the milk nutritional profile and reduces enteric methane emissions per litre. This lever is interesting to contribute to climate change mitigation but can also generate additional farm costs. Payment for Environmental Services, such as the Eco-Methane programme implemented by the association Bleu-Blanc-Cœur in France, can support a change of cows' diet in dairy farms through the valorisation of methane emissions reduction. The effectiveness of such a scheme depends on (i) the definition of a precise indicator of enteric methane emissions capturing the feeding effect, (ii) a payment level that would be sufficiently attractive to compensate for the additional costs faced by farmers. This study compares two indicators of enteric methane emissions to show the effect of taking feeding into account. It also assesses the extra cost of milk production if the grassland areas in fodder crop rotation systems were to be increased in French dairy farms in order to evaluate the economic incentives needed for improving dairy systems toward more environmentally friendly practices.

4.1.1.2 Data

To do so, we examine the impact of taking feeding into account in the calculation of enteric methane emissions of a panel of French dairy farms from the Farm Accountancy Data Network (FADN) by comparing an indicator constructed using the Eco-Methane methodology with an indicator that only takes into account productivity. A balanced panel of 735 FADN dairy farms for the years 2016 to 2018 was selected for the study (Agreste, 2020). This database is available online and is representative for socio-economic and accountancy information of French medium and large farms, and is therefore relevant for assessing the financial needs of dairy farms to join a national programme such as Eco-Methane. As the compositions of the feed ration and milk are not provided, information on dairy cows' diet is limited. However, data on the fodder crop rotation systems are available, which allows us to assess a change of crop rotation to approximate a change of feed composition.

Then, we estimate a variable cost function of milk production to assess marginal costs and evaluate the extra-cost associated with adding more grass in fodder crop rotation systems. Since the composition of cows' feed ration and milk are not available in the FADN, the effect of an improvement of the fatty acid profile cannot be directly analysed. Instead, we assume an evolution of the fodder crop rotation. As grass is a high source of omega 3 fatty acids strongly encouraged in Eco-Methane, we assume that a commitment to the programme would lead to an increase in grassland surfaces in farms. This hypothesis is quite strong and implies that our estimation of extra-costs does not take into account neither the strategy of supplementing the ration with other feeds with high omega-3 content such as extruded linseed, nor the optimisation of grazing increasing grass yield and quality without necessarily increasing grassland surfaces.

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Using the same balanced panel as previously, we evaluate the additional costs associated with an increase in grassland areas in French dairy farms.

4.1.1.3 Summary of the results

The Eco-Methane programme implemented by the association Bleu-Blanc-Cœur is an example of Payment for Environmental Services scheme supporting dairy farmers engaged in modifying the diet of dairy cows to reduce enteric methane emissions per litre of milk. The reduction of emissions is favoured on the one hand by improving cows' productivity, and on the other hand by integrating more fodder rich in omega-3 fatty acids such as grass and extruded linseed in cows' diet. Through the comparison of two indicators, our study verifies that enteric emissions per litre of milk are higher in mountains farms than in plains farms, but the difference is lower when the indicator takes into account the diet, which tends to be richer in omega-3 in mountainous areas (more grass fodders). In Eco-Methane, the payment level is conditional on the reduced amount of CO2eq, which makes the scheme a result-based PES. The programme's funding capacity depends on private donations and is currently not sufficient to induce a massive farms adhesion at the country level, limiting the scheme's environmental impact. To evaluate the willingness to accept of farmers for entering a PES scheme for the reduction of enteric methane emissions and its optimal payment level, it is necessary to know the additional costs of reducing emissions per litre of milk, and therefore of modifying dairy cows' diet.

In this study, we estimate a variable cost function based on French data from the Farm Accountancy Data Network. We evaluate the additional costs per litre of milk of dairy farms due to an increase in grassland area. For a given production level, producing milk with more grass fodder leads to no significant additional cost at the country level and in intensive plain production basins. We find significant extra-costs in dairy systems already relying substantially on grass fodders to feed the cattle (in mountainous areas and plain farms with less than 30% of maize silage in the fodder area). Our conclusions are robust to a change of model specification. These results provide first insights about how supporting a change in cows' diet could reduce GHG emissions. To strengthen their validity, this study could be pursued by an analysis of economic and fodder system data of farms already participating in Eco-Methane. It would allow linking grassland areas, marginal costs of milk production and reduction of enteric emissions, and estimate a cost function for the reduction of enteric emissions per litre of milk. In addition, the estimation of the extra-costs of modifying cows' feed could be improved by taking into account extruded linseed complementation. This research should contribute to define an optimal Eco-Methane payment for a given abatement target, hence reducing uncertainties regarding the compensation level for dairy farmers' and the amount actually abated by donors' contributions.

On a broader level, more insights on the impact of methane emissions reduction on production costs of livestock farms makes it possible to improve support for pressing abatement measures, and contribute effectively to achieve climate targets.

4.1.2 Finland: Participation and renewal of private forest owners' fixed-term forest biodiversity contracts in Finland

4.1.2.1 Background and objective

In Finland, besides the statutory biodiversity protection instruments, voluntary fixed-term contracts have been offered to private forest owners since 1997, and more extensively since 2004. These contracts are for 10 years. Typically, the core of the ecologically valuable habitat is

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protected by law, and the area around or connected to it is voluntary enlargement. Forest owners commit to restrict forest management actions in that area to protect and maintain the biodiversity of that site on his/her forest property. The compensation that owners receive is based mostly on the value of growing stock and market price of timber (Forest Centre 2021). The idea is based on opportunity costs: the compensation is designed so that it covers the losses of not harvesting timber during the contract period (10 years).

The contract is called environmental forest subsidy agreement, and it is one of the instruments in voluntary biodiversity programme for Southern Finland called METSO-programme (METSO Forest Biodiversity 2021; Ministry of Agriculture and Forestry of Finland 2022). The programme and the compensations to landowners are financed by the state budget. Forest owners sign the contracts with the Finnish Forest Centre which is state-funded organization acting on regional level.

In Finland, the Forest Act defines seven valuable forest habitats on which the ecological features must be maintained. METSO-programme enables larger protection around these valuable habitats restricted in law. Valuable habitats are, for example, springs, brooks, ponds and their surroundings, certain type of mire habitats, herb-rich forest patches, heathland forest islets in undrained peatlands, gorges and ravines, steep bluffs and sandy soils, exposed bedrock and boulder fields with lower wood production potential.

During recent years, the forest law and its criteria to define the valuable habitats and the way how compensations are defined has somewhat changed. One of the main legislative changes, in the year 2014, was that all the specific habitats protected by the forest law need to be small in area or have little significance for forestry purposes. For many of the forest owners this change implies that when renewing the ten years contract only the core of a large mireland or large herb-rich forest is now designated as valuable habitat. In addition, the compensation from protecting the smaller area is obviously also smaller. Typically, the areas around the core area could have been compensated by METSO-programme. However, the funding of the METSO-programme was temporary reduced, and the ecological criteria has changed in the year 2016. The emphasis is to protect the areas with forest cover, and therefore, for example, mire areas and exposed bedrock and boulder fields with sparse trees are not eligible anymore.

During the implementation of METSO piloting phase and actual METSO programme, a considerable number of voluntary 10-years contracts were made, especially during the five years period from 2004 to 2008 (Figure 1). Now these contracts have ended, and it would be time to renew them. However, not all contracts are renewed. Forest owners may want to take these areas under “normal” forest use. Another reason not to renew the contract is that the areas are no longer eligible for renewal, due to changes in criteria.

The aim of this study was to find out: 1) Why some contracts were not renewed? 2) How do forest owners feel when their original contract site or part of it was not anymore eligible for renewal? 3) What has happened or shall happen to the sites that have been left outside contracts and compensations in 2014-2018?

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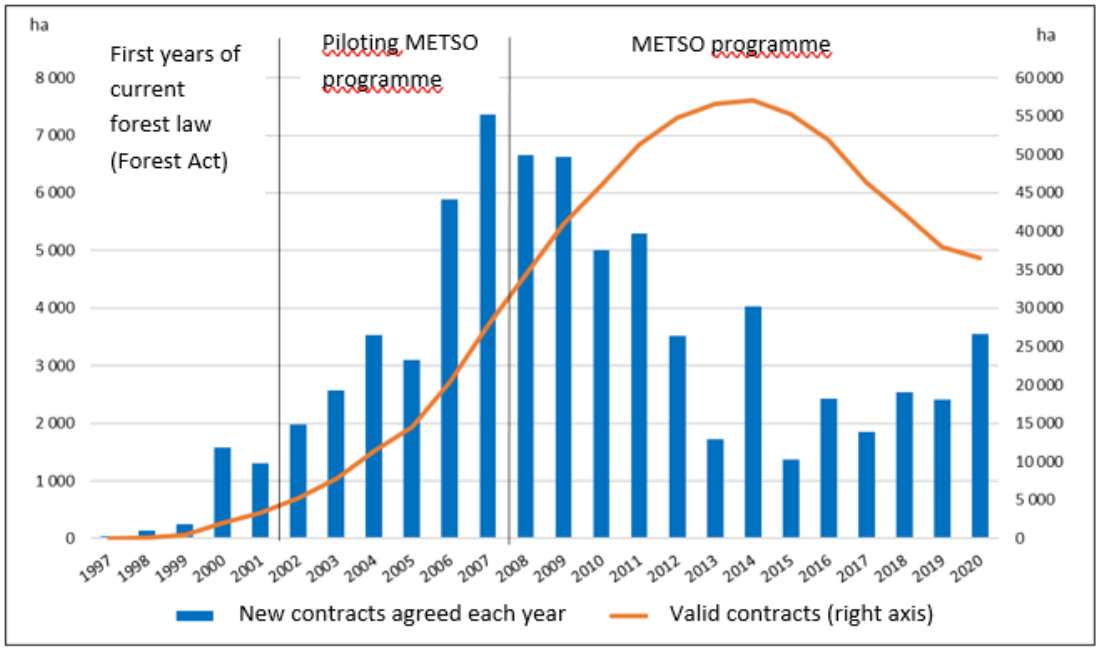

FIGURE 1. THE AREA (HA) OF NEW CONTRACTS AGREED EACH YEAR DURING THE YEARS (1997-2020) (LEFT AXIS) AND THE CUMULATIVE AREA (HA) OF VALID CONTRACTS (RIGHT AXIS). PICTURE PUBLISHED IN HÄNNINEN ET AL. 2021.

4.1.2.2 Data

This study focused on the environmental forest subsidy agreements that have been agreed during the years 2004-2008 and have thus ended during 2014-2018. During this time frame, 3 497 contracts were agreed and according to existing data received from The Finnish Forest Centre, 1 597 contracts were not renewed, at least not in similar form as they were initially made. The analysis was focused on private forest owners, and commonly or jointly owned forests were excluded. Private forest owners had altogether 1531 contracts involving 1411 forest holdings.

For our analyses, the existing contract data was received from the Finnish Forest Centre. This data included variables such as type of forest ownership, size and location of the holding, size of the contract area and forest use notifications. The contract data was completed with forest owner survey. Data collection from the forest owners was made both by email and phone. From the data of Finnish Forest Centre, this type of contact information was found for 1 281 owners. Email survey was sent to all the 811 forest owners who had email address. In addition, 88 forest owners were contacted by phone and 44 of them replied for phone interview (24 phone numbers were not in use). Altogether 421 responses were received, which is 47 % of those whose were reached for, and 33% of those whose contact details were available. The email survey was carried out in May-June 2020 and phone interviews in June-July 2020.

For this survey, we aimed to reach only the forest owners whose contract was not renewed with similar area delineation than what was initially agreed. However, 20% of the respondents replied that their contract was renewed with similar area delineation. 14% of the respondents replied that the contract was renewed with partly different areal delineation.

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4.1.2.3 Summary of the results

After ten years period, 56% of the contracts (1597 contracts, 30% of the area) were not renewed. The forest habitats on which the contract was not renewed were: 1) the immediate surroundings of springs, brooks and ponds (42%), 2) sparsely forested mire habitats (28%), 3) bedrock and boulder fields (24%) and 4) fertile patches of herb-rich forest (17%). Due to changes in criteria, in many cases, only the core of large herb-rich forests or pond area is now under contract. Moreover, the emphasis is now to protect the areas with forest cover, excluding sparsely forested mire areas or bedrock and boulder field areas, since this type of sparsely forested areas would usually be left untouched also without compensation.

According to forest owner survey, there were three main reasons why the contracts were not renewed:

1) In 46% of the cases, the Finnish Forest Centre was not able to renew the contract, due to changed ecological criteria.
2) In 35% of the cases, forest owners felt that the renewal of the agreement has not been handled or process is still in progress or pending.
3) In 19% of the cases, forest owners didn't want to renew, since they felt that the monetary compensation offered was not enough or the contract limits other uses of the forest.

Half (46%) of those forest owners whose contracts were not renewed, were unsatisfied (Figure 2). Those owners, whose contracts were partly or completely renewed were more satisfied. Owners were unsatisfied because they would have wanted to continue the contract and some of them didn't have any other use for that forest site (39%). Many of them (17%) were unsatisfied since they were ignorant about the present state of their valuable forest area, whether it is applicable for protection or not, and they felt that the process was still unfinished. Part of the forest sites are protected by law and they need to be left untouched, however they are not compensated anymore, and this created dissatisfaction among owners (15%). Some of the owners felt that the politics has been changing too rapidly (8%) or that the renewing process and information of the reasons that caused contract not to be renewed was poorly managed in the Finnish Forest Centre (6%).

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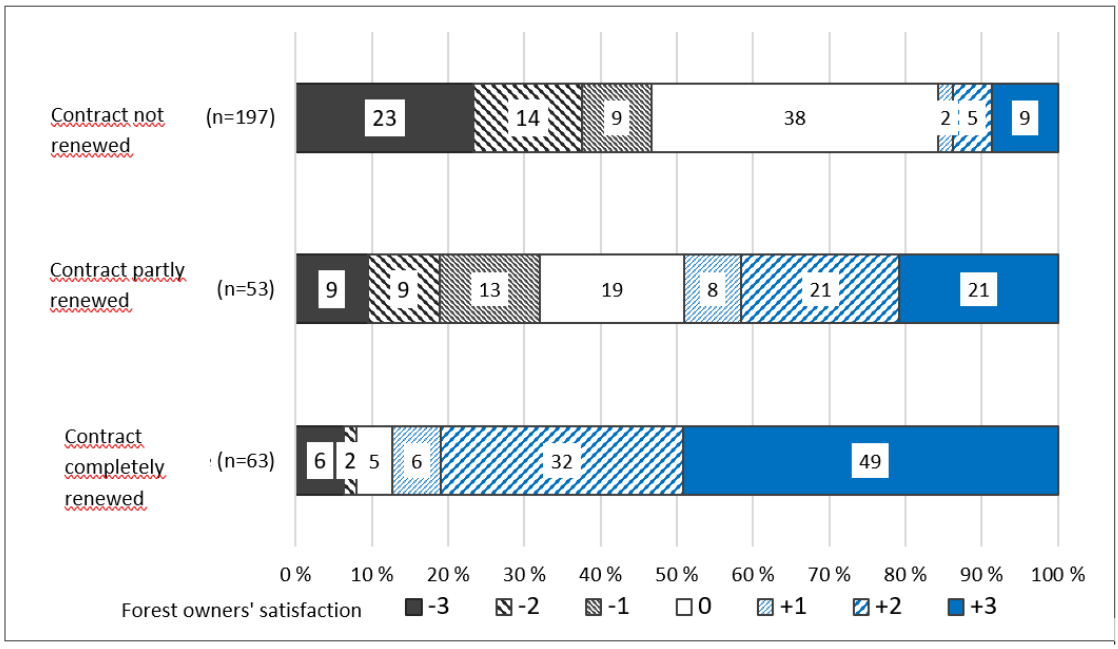

FIGURE 2. FOREST OWNERS' SATISFACTION WITH THE CONTRACT RENEWAL DECISION ON A SCALE OF -3 (VERY DISSATISFIED) TO +3 (VERY SATISFIED).

These results imply that the majority of the owners was willing to continue the contract, but due to changed ecological and legislative criteria it was not possible anymore. Part of them understand the changed criteria and the reasons that have led for these changes. However, the change of criteria also creates mistrust among forest owners. Also, some of them are not up to date with the state of their contract, whether it exists or not and what are the possibilities to renew it. This is the case especially among women forest owners and the kind of owners who are more passive with forest management in general.

Owners were asked what have happened with the forest sites that were left without the contract, and how they are going to manage these sites within the next 10 years. According to results of the survey, 26% of the respondents have decided to preserve the sites without the contract. Most of the owners replied that the areas will be left untouched since owners have not yet decided what to do with them, it is not financially beneficial harvest there, or the management actions or harvesting is forbidden due to forest law (21%). Only 6% of the owner have done the kind of management actions or cuttings that may harm the biodiversity of the forest site. The data from the forest use notifications supports this result. Within the next ten years, 20% of the owners are planning to conduct management actions or cuttings that might harm biodiversity.

According to results, 74% of the renewed contracts continued as 10-year contracts and 23% were turned into permanent conservation agreements (23%). Some of these owners noted that fixed-term period had been good trial for permanent protection agreement.

During the past twenty years, METSO program has been an instrument that has introduced private forest owners into voluntary biodiversity protection agreements. Forest owners have been willing to participate and offer their forest sites into the programme in exchange for financial compensation. The limiting factor has been state funding and the resources allocated for the programme.

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4.2 Secondary analysis to estimate adoption drivers of innovative contractual solutions

4.2.1 Italy: Identification of compliance costs estimates

4.2.1.1 Background and objective

The main focus of UNIBO activities was to investigate data availability in the Emilia-Romagna Region, pointing at data from previous studies and suitable to be used to support modelling in WP4. The focus was marginally on factors affecting adoption, as this has been already investigated in the region. Instead, the main objective was to identify economic information suitable to be used as estimates of compliance cost for participation to AECPG measures. In particular, in order to support the analysis of detailed contract design features, attention has been given to studies providing information on range and distribution of compliance costs among farms.

4.2.1.2 Data

The study involved the collection of information from five existing studies. For four of them, published information was collected and compared. For the fifth study, the background dataset was retrieved and elaborated to provide a feasibility analysis of its use for WP4.

All studies concerned Emilia-Romagna, focusing on compliance costs to different AECPG-related measures or to land rent intended as the opportunity cost of implementing a measure that would substitute crop production. The background information include a variety of sources:

- Original data collected by the regional administration in the framework of their monitoring activities and concerning technical-economic comparison of enrolled farms vs. conventional farms;
- FADN data (Italian or regional database);
- Info on land values and rents derived from expropriation values.

4.2.1.3 Summary of the results

The summary of the result reported from selected studies is reported in Table 1.

Source	Technology/crop	Compliance costs range	Compliance cost function
Bazzani and Viaggi 2004	Integrated wheat production	-36,5 to +168,7 euro/ha	
Viaggi, Merri, and Minarelli 2016	Integrated wheat production	-410 to +750 euro/ha	
	Organic wheat production	-220 to + 1205 euro/ha	
	Integrated Pear production	-6000 to + 5000 euro/ha	
	Organic tomato production	-1060 to 4500 euro/ha	
Viaggi, Raggi, and Gallerani 2012	Integrated wheat production		y cost = 2E-13x3 - 5E-08x2 + 0,003x + 41,273 R^2 = 0,9586
	Substitution of wheat cultivation		cost = -5E-13x_3-1E-07x_2 + 0,0126x R^2 = 0,9772

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Vergamini, Viaggi, and Raggi 2020	Substitution of crop mix – scenario 1		cost = -5E-13x3-1E-07x2 + 0,0126x R² = 0,9772
	Substitution of crop mix – scenario 2		cost = 8E-09x3 - 9E-05x2 + 0.3674x + 66.597 R² = 0.99
	Substitution of crop mix – scenario 3		cost = 8E-09x3 - 9E-05x2 + 0.4012x + 40.088 R² = 0.9894
	Substitution of crop mix – scenario 4		cost = 4E-09x3 - 5E-05x2 + 0.3429x + 62.225 R² = 0.9934

TABLE 1. SUMMARY OF RESULTS OF SELECTED STUDIES

Bazzani and Viaggi (2004) and Viaggi, Merri, and Minarelli (2016) report straight intervals of compliance costs for different crops and technologies. In all cases, the most interesting feature is that compliance costs may be either positive or negative, implying that such technologies as organic or integrated production may yield benefits rather than costs for a subsample of farms. The figures come from small samples and comparison with counterfactual farms, and the original studies emphasise the potential limitation of this approach, in particular for the difficulties in finding truly comparable farms. The absolute values are relevant enough to justify attention to the purely economic driver, though a number of farms have actually a compliance cost around zero, which may make more plausible a prevailing attention to other drivers.

Viaggi, Raggi, and Gallerani (2012) and Vergamini, Viaggi, and Raggi (2020) focus attention on the distribution of compliance costs in a larger population, in order to use these data as a basis for modelling auctions of AECPG contracts. Internal heterogeneity remains a very relevant issue. In addition, these studies point at the fact that the actual compliance cost would change with the explicit target population or with the interested population depending on the policy design.

A similar study on distributions has been performed with the background data used in Zavalloni et al. (2021).

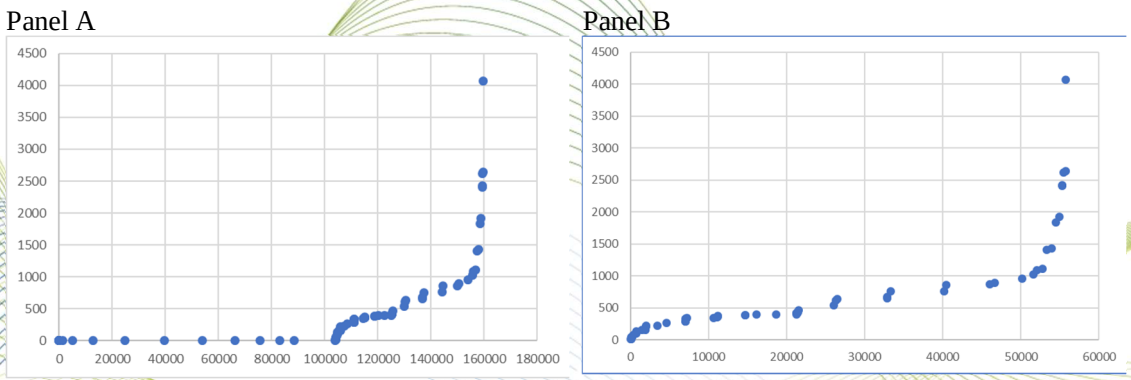

FIGURE 3. DISTRIBUTION OF RENT IN THE HILL AND MOUNTAIN AREA OF THE PROVINCE OF BOLOGNA, INCLUDING FOREST AND UNCULTIVATED LAND (PANEL A) AND EXCLUDING FOREST AND UNCULTIVATED LAND (PANEL B) (RENT IN EURO/HA; CUMULATED AREA IN HECTARES).

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The figure shows the distribution of calculated land rents in the hill and mountain area of the province of Bologna.

The result show a high level of heterogeneity even in a restricted area. This heterogeneity will be key in modelling impacts and connection of measures with land rent in WP4.

Heterogeneity is restricted to factors directly related to land types, being the rent calculated on the basis of land use (crop type) and slope. The latest, often given little attention, may actually be a key characteristic for micro-analyses in hill and mountain areas. The data suffer however from the fact of not including behavioural aspects connected to individual farmers. They can hence be considered as complementary to survey-based studies in fully interpreting farm choices.

4.2.2 France: An econometric methodology to model contracts uptake applied with the Farm Accountancy Data Network

4.2.2.1 Background and objective

Voluntary contracts for delivering environmental services are offered in two schemes of the CAP's rural policy, (i) support to organic farming (OF), and (ii) agri-environmental-climate measures (AECM). OF are dedicated to farms undertaking a conversion towards organic farming or already certified organic, while AECM are available to any farm complying with a set of specific management requirements targeting an environmental objective. After 30 years, the voluntary environmental schemes of the CAP provided insufficient and unsatisfactory environmental additionality. Low and unbalanced funding in comparison with income support often do not lead to enough participation and effort to trigger significant environmental improvements (Guyomard et al. 2020). Higher environmental efficiency can be reached by better targeted support, through the rebalancing of the budget between direct payments with little conditionality on practices, and environmental incentives. All sources of financial incentives, including first pillar payments, are important drivers of the decision to participate in environmental schemes (Van Herzele et al. 2013).

In this study, we develop an econometric model of farmers' voluntary environmental contracts adoption accounting for the effect of the amount of direct payments received (decoupled and coupled support). The model describes an equilibrium of environmental commitments demand of by authorities and supply by farmers for a given budget allocation among different policy instruments.

4.2.2.2 Data

The model is developed with national data from the farm accountancy data network (FADN) providing a large sample of observations from participants and non-participants in OF and AECM. A sample of 7,194 farms from France Metropole representative of 289,260 medium and large farms in 2019 was selected. Remote access to the French FADN data has been made possible within a secure environment offered by the CASD (*centre d'accès sécurisé aux données*', Ref. 10.34724/CASD), so that farms with organic certification could be identified.

A generalised Tobit model was applied to simultaneously estimate for each farm of the sample, for AECM on the one hand, and OF on the other hand, the probability of environmental contract uptake (selection equation) and the minimum farm level payment triggering adoption (outcome equation). Explanatory variables were chosen from the literature. In addition to the covariates described in Table 1, we control for the region in which the farm is located and farm

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specialisation. Controlling for organic certification identifies the type of OF payment, as only certified organic farms can apply to support for maintenance of organic farming.

	Weighted mean	Standard deviation
Participation in AECM	0.11	1.99
Participation in OF	0.07	1.64
***AECM payments* (€)**	7,271.4	43,754.3
***OF payments* (€)**	9,978.3	74,338.0
Age (years)	51.4	61.7
Labour (AWU)	2.0	13.5
Utilised agricultural area (ha)	90.7	499.3
Permanent grasslands (ha)	23.5	249.4
Land rent (€/ha)	722.7	18,515.1
Depreciation (€/ha)	32,693.9	227,212.4
Decoupled payment (€)	18,991.9	104,964.2
Coupled payment for suckler cows (€)	2,264.5	29,753.4
LFA payment (€)	3,737.8	46,237.1
Organic certification	0.09	1.8

TABLE 2. DESCRIPTIVE STATISTICS OF THE SAMPLE.

Source: 2019 French FADN data.

Focus was put on trying to capture many sources of farms heterogeneity to overcome the absence of information on the specific contract requirements, payment and eligibility rules faced by farmers. On-going model development aims at identifying the type of measure (in particular those with a result-based or collective component), and the amount of hectares enrolled by farmers.

4.2.2.3 Summary of the results

The Tobit regression model provides estimated coefficients of the effect of the explanatory variables on both the decision to participate in an environmental scheme and the farm level acceptable payment triggering participation.

Direct payments have a significant influence on the decision to participate and the acceptable payment to join AECM and OF. The direction and extent of the effect however, differs according to the type of direct payment and environmental scheme. The effect of direct payments on the probabilities to participate in AECM or OF is significant but marginal. More decoupled payments significantly increases the acceptable payment for enrolling in both schemes. Higher coupled support for suckler cows has opposite effects, decreasing the acceptable payment for OF, and increasing it for AECM. Those results show that the amount of pillar 1 incentives affect the behaviour of farmers regarding the uptake of environmental contracts. A working paper in French includes preliminary model results to simulate the increase of AECM and OF uptake with a transfer of direct payments to environmental programme (Chatellier et al. 2021). The other

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covariates included in the model are also significant in explaining farmers' behaviour, supporting the literature. Interestingly, the cost of renting land impacts OF and AECM uptake differently. The model will be further improved to better capture the effect of land tenure on contracts adoption.

4.2.3 Italy: A systematic review of attributes used in choice experiments for agri-environmental contracts

4.2.3.1 Background and objective

Contract attributes are strong motivators for eliciting farmers' preferences for a particular agri-environmental scheme (AES). Studies generally use evidence from previous literature to select the contract attributes and their levels for their choice experiments (CE). Only a few studies have conducted in-depth literature reviews to understand why farmers join a particular AES and the attractive attributes in a contract that motivate farmers' participation. However, there is still a substantial knowledge gap in the literature about attribute selection for contract design because of the lack of a definitive catalogue of management and policy-based attributes used by previous studies. This gap creates a divide between contract attributes studied by researchers and actual attributes preferred by the farmers, leading to inefficient contract designs. Thus, this study aims to systematically review AES studies' recent literature that uses CEs to reveal the common attributes for testing contract designs and farmers' preferences for those contract features. The study also tries to categorize the attributes into broad typologies and highlight the lesser-used attributes that can be further explored in future AES studies.

4.2.3.2 Data

The study used the PRISMA methodology for the systematic review. PRISMA is an evidence-based method for reporting in systematic reviews and meta-analyses. In this study, the PRISMA flowchart and checklist were downloaded from Moher et al. (2010) and applied to the study following the methodology of Koutsos, Menexes, and Dordas (2019) for agricultural science reviews. Using the databases Web of Science and Scopus, 34 studies were identified that matched the inclusion criteria and were analyzed further for an in-depth review.

4.2.3.3 Summary of results

From the 34 studies, 32 attributes were extracted and were classified into 5 typologies: 'monetary' (7 attributes), 'general' (4 attributes), 'flexibility' (6 attributes), 'prescription' (12 attributes), and 'purpose' (3 attributes). Monetary attributes were defined as the economic motivators of a contract that include attributes like '(annual) payment,' 'conditional bonus,' 'others like fine, gross margin, etc.' etc. General attributes defined the basic contract elements such as 'contract duration,' 'area under contract,' and 'availability of training/scheme support.' Efficient contracts were also found to include flexibility attributes that provide the choice of contract elements to the farmers, like 'flexibility to adhere to contracts,' 'flexibility to decide area under contract,' 'flexibility to decide contract duration,' etc. Though monetary attributes should theoretically define farmers' choices, general design attributes and flexibility attributes have been observed to be more critical for farmers' participation and willingness to accept.

The study also extracted the lesser-used attributes, including the contracts' technical and management aspects and purpose. These include 'monitoring," communal participation,' 'neighbor-effect,' 'eco-label,' 'risk,' etc. They have been overlooked by most of the studies probably due to lack of literature to support their importance, or maybe these attributes require

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exhaustive coding in models. Market-based and value-chain attributes such as 'crop failure,' 'price fluctuations,' 'climate risks,' etc., have also not been explored much, which can become important under uncertain future scenarios (like climate change, socio-economic change, etc.). All contracts also had at least one 'purpose attribute' that iterates the purpose for which the farmer will accept the contract prescriptions. These attributes could include a specific conservation activity, afforestation, land allocation to environmental activity, chemical reduction, etc.

This review indicated that CE studies should take more advantage of the virtual environment they are set to test and experiment on a broader range of attributes across different areas and contract types. The results of this study have been used to select variables that were used in WP3 surveys of the CONSOLE project, in particular the attributes concerning contract design.

5 General insights

5.1 Replicability of data usage

The use of public data such as FADN is replicable also in other countries of the European Union. This allows for large scale analysis or comparison.

Other locally available data may better fit with the problem of understanding participation to AECPG contracts, bur are more heterogeneous in nature, rely on smaller samples and do not provide consistent dataset over time.

Luke received existing register data from Forestry Centre and supported this data with forest owners' survey. In the original manuscript (Hänninen et al. 2021), data collection, variables used, and analysis done are explained. Register data that combines forest owners' personal information, information about the protection agreements and forest use notifications is not public, and to access this type of information a separate permission from Forestry Centre is needed. Forest owner survey data is available in Luke after the CONSOLE -project ends (SPSS form).

5.2 Of the use of secondary data to analyse AECPG contract solutions and modelling

There is a general lack of indicators of environmental impacts in public database that could allow to understand farmers' behavior. However, secondary data analysis can be useful whenever it is possible to construct database using data matching that allow to capture both economic behavioral descriptors of landowners and environmental impacts descriptors.

In such case, descriptors of the contractual solutions can be linked to a larger database to build the counterfactual. This can allow to measure the impact of the environmental measure on farmers' behavior and environmental outcomes.

The Finnish analyses dealt with private forest owners' fixed-term biodiversity protection agreements and it combined existing register data and additional survey data. The analyses revealed that there are several sources of leakage that can take place when temporary contract solutions are employed. These are 1) changing selection criteria or legislation during the contract period; 2) decreasing funding; 3) non-functional process for renewing contracts; and 4) changes in owners' willingness to participate to temporary contract solutions. When planning fixed-term contract solutions the renewal process in particular needs to be addressed already from the beginning. The study also highlights the importance of existing register data or database. It is

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important that the characteristics of the areas that are protected are properly registered and maintained. Such data enables subsequent policy analysis.

Usually innovative contractual solutions do not implement the observatory measures that could allow the observation of the counterfactual that is necessary to be able to measure the additionality of the measure. More generally, ex post data only refer to measures that have been implemented in the past, so the use for the analysis of innovative contract solutions may require strong assumptions. This is even more important considering that the attitude for contract solutions as studied in CONSOLE may depend on a number of implementation details.

Similar conclusions have been issued in the Common monitoring and evaluation framework of the CAP, where these principles are reaffirmed, but for all that in the implementation of measures, actions to measure the impacts are rarely taken from the start of their application.

High expectations are placed on new digitalization instruments allowing recording and management of high quantity of data, including potential connection between management and environmental information. An explicit effort for coordination/homogenization of this data is needed since the set up. Differential (additional) effects of measures remain however an issue.

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