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New pathways for improved delivery of public goods from agriculture and forestry

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1. INTRODUCTION

This special issue of Bio-based and Applied Economics (BAE) features a selection of five papers developed within the EU H2020 project 'CONtract SOLutions for Effective and lasting delivery of agri-environmental-climate public goods by EU agriculture and forestry' (CONSOLE) (H2020-RUR-2018-2, GA No. 817949). CONSOLE has been comprehensively investigating the effectiveness, efficiency and longevity of innovative contract solutions for the provision of Agri-Environmental-Climate Public Goods (AECPGs), the acceptance of such contracts amongst European farmers and stakeholders, as well as the drivers and mechanisms influencing the implementation.

Despite large budgets for policies devoted to environmental objectives, the ongoing decline in the provision of AECPGs in many European agricultural and forest ecosystems and the growing societal concerns about ecological issues make it necessary to improve the environmental effectiveness in particular of the Common Agricultural Policy (CAP) (Pe'er et al., 2022). The Green Deal of the EU and the Farm-to-Fork Strategy are part of the EU's plan to respond to these challenges. They highlight the relevance of the agricultural sector for the provision of a multitude of AECPGs, such as biodiversity, climate regulation, water and soil protection. To achieve real change, in addition to rethinking and strengthening actions set by the Agri-Environmental and Climate Schemes (AECS), the attention towards innovative, more effective, and efficient instruments is increasing (Targetti et al., 2022). The most prominent examples are result-based and value chain-based solutions, as well as approaches that promote collective implementation. In addition, land tenure contracts with environmental requirements are in the focus of interest. Although promising, all of these tools involve a number of challenges for their successful design and implementation, such as acceptance and enablement of

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farmers, knowledge and training needs, equity/fairness, and compatibility with agricultural business.

In this editorial paper, we describe the CONSOLE framework as a major background for the evaluation of novel contract solutions and the development of the research papers for this special issue. The framework describes three main topics covered by the papers in this special issue: Innovative designs (of AECS), attitudes of farmers toward these new approaches, and drivers for their successful implementation.

In the following, we first describe the CONSOLE framework and then present different aspects concerning contract design and innovative contractual options of AECS. Finally, we introduce the papers of the special issue of BAE: 'New pathways for an improved delivery of public goods from agriculture and forestry'.

2. THE CONSOLE FRAMEWORK

The analytical framework developed in the CONSOLE project aims at the identification of a set of contract elements to be considered in the design and analysis of AECS (Fig. 1). Specifically, it identifies elements and factors characterizing an agri-environmental contract along three main groups (Viaggi et al., 2022):

- *Contract design* includes the specific elements characterising AECS contract like objective, duration, level of payment, etc.;
- *Mechanisms and impact* comprise the factors that influence the effectiveness of the contract such as attitude of farmers which in turn affect the acceptability of the scheme, etc.;
- *System features* consists of a range of drivers including governance, market, and local-scale conditions that affect the impact and efficiency of a contract.

Besides these elements, factors, and drivers that define and influence the success or failure of a contract, the framework also indicates a set of *performance criteria*. These criteria are directly or indirectly related to several items included in the contract design, mechanisms and system features. For instance, acceptance, longevity, effectiveness, profitability, etc. are only some of the criteria that can be considered in the evaluation of a contract and are related to farm-level characteristics (for example, farm structure, farmers' attitudes) and regional-level characteristics (for example, environmental conditions, formal and informal institutions).

3. CONTRACT DESIGN: CURRENT AGRI-ENVIRONMENTAL AND CLIMATE SCHEMES AND POTENTIAL FOR INNOVATIVE SOLUTIONS

The provision of public goods by agriculture is largely determined by the management and practices applied at the farm and regional scale. Therefore, policies usually include a variety of instruments to improve the environmental performance. Currently, the main approach of

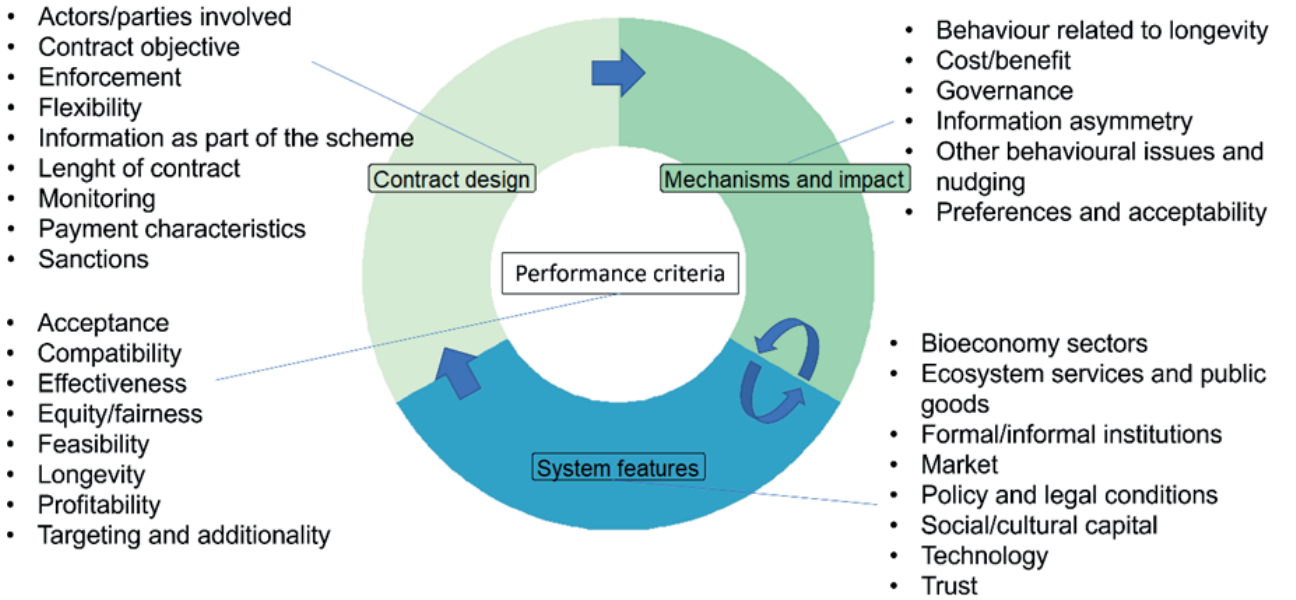

Figure 1. Analytical framework developed in the CONSOLE project for the analysis and design of agri-environmental and climate contracts (d'Alberto et al., 2024).

agricultural policy efforts to maintain and/or improve AECPGs on farmland are voluntary action-based AECS. These schemes consist of prescribed practices, and participating farmers receive monetary compensation for income forgone and increased costs associated with the implementation of the practices considered capable of improving the environmental performance of the farm. Such payment schemes are relatively simple to implement, do not require complicated monitoring and do not incur inequality concerns (usually the same 'average' price is offered to farmers for undertaking a given action). Action-based AECS are acknowledged to have positive effects on the environment (Herzog et al., 2005), while their overall environmental effectiveness remains relatively low considering the financial resources put into these schemes (Batary et al., 2015). Such schemes incur a range of problems, as they typically over-reward 'all but the marginal producer' (Hanley et al., 2012). This effect is linked to the actual provision of public goods from farmland, which is affected by spatial variation of opportunity costs and information asymmetries between 'sellers' and 'buyers' of AECPGs, leading to a spatial policy mistargeting, but also potential spatial under-provision/under-supply of AECPGs (Zasada et al., 2017). The availability of local-scale information could improve the spatial targeting of policies and improve the cost-effectiveness of payments, but such a detailed level of information is usually challenging or not affordable to collect (Ferraro, 2008). Other negative aspects of action-based AECS that are often criticized comprise a range of less tangible impacts related to the potential risks of commodification of public goods and the disconnect between the objectives of the scheme and the values and moral responsibility of farmers. Moreover, another criticism is related to the long-term effects of action-based AECS. An essential condition to ensure permanent environmental improvements is to link farmers' acceptance of a scheme with a major attitudinal change that corresponds to their interests and values (Burton et al., 2008). Farmers with interest in agroecology, for example, tend to dislike having to rely on payments for good behavior and, in some cases, prefer to be remunerated by the market because their business model is successful. Farmers recognizing an inherent value of nature, for instance, are found to apply more holistic management strategies benefitting a diversity of AECPGs (Klebl et al., 2024).

3.1 From action-based to result-based schemes

To tackle the low efficiency and effectiveness of action-based AECS, a stronger focus on what is actually achieved in terms of environmental goals is considered a relevant improvement. Result-based approaches in this respect are innovative solutions because they are based on a direct link between payment and the achievement of environmental goals, while no requirement of the implementation of specific practices is included. This allows farmers to be more flexible in their management, but these contracts score significantly worse in terms of practicability, and therefore their application on a large scale is rare (Drechsler, 2017). The two main limitations of result-based schemes concern the uncertainty of payment as it is dependent on the achievement of an environmental result, and the ability to measure it. These limitations considerably reduce the acceptance of these contracts because farmers incur risks of failing to achieve the aims and are exposed to public scrutiny as they become a seller of public goods (Haaren and Bathke, 2008; Atari et al., 2009). On a more general level, the additionality of result-based approaches is a relevant concern. In other words, doubts are raised about the prospect of paying farmers for results that would be actually delivered even without the policy intervention. Indeed, result-based payments potentially incentivize land enrollment where the target result is already achieved, resulting in a zero-additionality effect (Uthes and Matzdorf, 2013).

3.2 Collective implementation

To improve the capacity of AECS to deliver public goods such as farmland biodiversity, the coordination of interventions at the landscape level to maximize the positive outcome (for example, adopting 'green' practices in different landholdings) is also proposed. In contractual solutions based on collective implementation and/or cooperation, farmers and/or private/public landowners voluntarily enter a joint, collective partnership to commonly deliver a specific environmental or climate action goal. This means that farmers, foresters (and other stakeholders) cooperate (by establishing an entity with or without legal personality) to achieve a specific environmental target. Contract solutions that propose collective implementation or cooperative/collaborative elements often address a territorial/landscape level to deliver public goods "across field borders". They aim especially for environmental results, which can hardly be improved by measures on singular fields and plots (e.g., water quality, maintenance of habitats, peatland rewetting). The environmental effectiveness of coordination depends on the public good addressed. For example, in the case of habitat maintenance for a particular target species it relates to the habitat requirement of that species. In cases where the spatial characteristics of habitats and land ownership

do not overlap, collective contracts are more efficient in ensuring "economies of configuration" (Franks, 2011). The design of collective AECS is relevant, as it targets groups of landowners, rather than individuals, so that agri-environmental efforts are spatially coordinated (Prager, 2015). In general, collective and cooperative/collaborative approaches can be used to address problems that cannot be solved individually or to achieve specific environmental improvements that can be achieved better by working together.

Collective approaches are nevertheless affected by an increased complexity of the policy design and higher transaction costs, which limit the adoption of the schemes (Zavalloni et al., 2019). In general, the success of collective contracts depends on the willingness of neighboring land managers to work together, on the existence of formal or informal institutions capable of implementing and coordinating the contract and the perceptions of these coordinating institutions (Franks, 2011; Häfner and Piorr, 2021).

3.3 Value chain-based solutions

Some contract solutions consider the delivery of public goods in connection with the production of private goods. These solutions are motivated by engaging different or all parts of a value chain, and the environmental benefits provided by the supplying farms are often part of the food companies'/retailers' marketing strategies. In a value-chain contract, farmers accept to meet specific environmental requirements and receive monetary support from market actors. Possible examples are reduced fertilization, higher animal welfare standards, preservation of biodiversity, etc. The monetary support can take the form of sale guarantees, price premiums, and/or the use and marketing of products under specific brands. Moreover, some value chain-related contractual solutions provide an example of a way to better support and market organic production.

Value chain contracts are essentially based on the capacity of the market to reward the public goods attached to the production of a specific private good (food). The advantage is the reliance on market mechanisms and the more direct link with consumers without incurring in the distortionary effects of incentives or regulations. However, conveying information about the environmental performance of a product is not always straightforward. Following economic principles, Jack et al. (2008) notice that people are likely not disposed to pay for something that they can receive for free. That differentiates between public goods like drinking water where the beneficiaries see a direct advantage, and other goods that are non-excludable like climate change mitigation or biodiversity. This means that discrimination of the link between product and environmental performance is necessary, and not all public goods have the same communicative grip. For example, AECPGs related to regulating services are characterized by an indirect contribution to society (Diaz et al., 2018) and thus could be more difficult to attach to a product compared to AECPGs related to e.g. cultural services (Targetti et al., 2021). Short supply chains are easier to develop because the link between consumers and promoted AECPGs is more direct, while the inclusion of large-scale public goods such as the mitigation of climate change is more difficult. A common problem concerns the need to mark up the value chain products with labels. Given the high number of labels that are present on market shelves, labelling of public good related products risks being not effective in communicating with consumers. Another problem of value chain contracts is the distribution of the added value along the value chain. Value chain contracts include a wide range of different approaches and arrangements between different actors along the value chain. In a recent report, Biber-Freudenberger et al. (2019) concluded that the actors that should be targeted by policy to promote biodiversity are farmers and consumers, at each end of the value chain. This can strengthen the position of the farmer in the value chain through stronger bottom-up approaches. There are risks, however, that farmers have not enough bargaining power in comparison to big food companies or retailers. This risk involves mistrust in the contract by farmers and to some extent by the consumers that may value a food product for the level of fairness and transparency of its production process. Additionally, also the majority of currently implemented value-chain approaches are based on action-based measures, potentially lacking environmental effectiveness (Bredemeier et al., 2022)

3.4 Land tenure contracts with environmental requirements

A common drawback of AECS also concerns the trade-off between acceptance by farmers and length of contract. In general, longer contracts are less attractive to farmers because their room for maneuver is limited (Raina et al., 2021). However, longer contracts are often more effective or even necessary to achieve an environmental target. This involves the relevance of land tenure contracts including land tenure arrangements with environmental clauses. Indeed, these types of contract are usually able to reduce the trade-off between contract length and acceptance as the possibility to benefit from reduced loans for a longer time range is seen positively by a land-tenant.

For the FAO, "*Land tenure is the relationship, legally or customarily defined, between people, as individuals or groups, with respect to land. (For convenience, 'land' is used here to include other natural resources such as water and trees.) Land tenure is an institution, that is, rules invented by societies to regulate behavior. The rules of tenure define how property rights to land are to be allocated within societies. They define how access is granted to the rights to use, control, and transfer land, as well as the associated responsibilities and restrictions. In simple terms, land tenure systems determine who can use what resources for how long, and under what conditions*"[1]. The terms land tenure and land rights are often used interchangeably. Land tenure contracts devoted to the improvement of AECPGs have clauses for the improvement or conservation of environmental assets. Landowners (private or public) lease their land to farmers, foresters, or third parties under certain conditions and accept a lower lease payment to compensate for additional environmental or climate action efforts by farmers. These efforts serve to achieve some form of ecological or environmental improvement. However, these contract types may be hampered by legal issues or not considered at all by private owners.

In many cases and usually in more marginal areas, landowners are not interested in selling the land, but have interest in preserving their land in good conditions. For instance, particular forms of properties (e.g. public lands, Church properties, foundations, etc.) have institutional mandates (formal or informal) of good management. In other cases, land fragmentation causes transactional problems that hinder organization and rational management. In these cases, forms of land tenure with clauses can be effective. However, the success of these contracts is often linked to arranging an easy and comprehensible contract type for the owners and/or the availability of an intermediary actor able to manage the contracts efficiently (Napoléone et al., 1995; The Nature Conservancy, 2019).

4. PRESENTATION OF THE SPECIAL ISSUE

In this chapter we present the five papers included in this special issue and how they are related to the aspects outlined in the previous chapter.

The paper of Tyllianakis (2023) assesses the perspectives of upland Yorkshire farmers in the United Kingdom (UK) regarding the Landscape Recovery scheme, a soon to be rolled out agri-environmental initiative designed to promote collaborative efforts for landscape-wide environmental improvements. With the UK having left the EU, proposals are being made in its agricultural policy to move away from 'Direct Basic Payments' for farmers and implement a system with a stronger focus on 'public money for public goods'. The Landscape Recovery scheme is the most ambitious scheme within this new envisioned system. Employing Q methodology, the paper identifies diverse viewpoints among farmers, who largely depend on government subsidies and are involved mainly in sheep and beef farming. Specifically, the analysis uncovered three main discourses: pragmatic yet environmentally conscious farmers, pragmatic objectors, and risk-averse environmentalists. Pragmatic yet environmentally conscious farmers are in general open to AECS, as they perceive them as a means to achieve their two main goals (financial survival and environmental stewardship), but are at the same time resistant to the Landscape Recovery scheme, citing its complexity and perceived misalignment with these goals. Pragmatic objectors prioritize financial compensation and reduced bureaucracy, showing resistance to long-term contracts, collaborative efforts and contracts addressing the delivery of multiple AECPGs. Risk-averse environmentalists show a varied interest in environmental issues, particularly ones related to climate change, but prefer simpler contracts in terms of monitoring, indicating a preference for schemes that are less demanding (and risky) yet environmentally beneficial. Across these discourses the results reveal a general preference for "broad and shallow" AECS that offer straightforward requirements, as opposed to the more ambitious Landscape Recovery scheme, and a desire to merge economically viable practices with environmental objectives. Aspects regarding payments, free advice, duration and scope seem to inhibit the endorsement of the Landscape Recovery scheme. Overall, this case study provides unique insights into farmers' viewpoints on these innovative concepts the UK is planning to introduce. It is also highly interesting from the perspective of EU agricultural policy, which also plans to move more into this direction, even though the author makes clear that generalizing the findings is not possible and also outside the purpose of Q methodology.

Le Gloux and Dupraz (2023) do not explore new AECS, but rather carry out an ex-ante analysis of the potential effects of reallocating the Common Agricultural Policy (CAP) budget from income support to already existing environmental incentives, specifically AECS and organic farming (OF) support, using French farm accountancy data network (FADN) data from 2015 to 2019. The methodological approach of the study involves estimating a generalized Tobit model for the voluntary

[1] "3. WHAT IS LAND TENURE" (available at: http://www.fao.org/3/y4307e/y4307e05.htm#TopOfPage).

adoption of these environmental contracts and acceptable farm-level payment triggering this adoption, predicting new adoption probabilities and acceptable farm-level payments under reduced direct payments, and simulating budget reallocation towards environmental incentives. The analysis is based on an unbalanced panel of 36,251 farm observations, providing insights into the total farm-level payments received for AECS and OF support contracts. The findings indicate that reallocating an additional 7.5% of direct payments towards AECS and OF support significantly increases participation rates in these programs. This effect is attributed to two main incentives: increased public funding for environmental commitments and the indirect influence of reduced direct payments, which lowers the acceptable farm-level payment for participating in OF support. However, the study also acknowledges limitations, including insufficient information to capture the diversity of AECS eligibility and measures adopted by farmers, unobserved factors influencing adoption decisions, and the potential market repercussions of significant policy changes. In conclusion, the study suggests that decreasing direct payments with little environmental conditionality and increasing targeted payments for environmental public goods can enhance the adoption of sustainable farming practices. While the current regulation's transfer limit may not suffice to meet the Farm to Fork target of 25% organic land, it can substantially contribute to this goal. Finally, the study calls for further research to refine the modelling of environmental contract adoption, highlighting the need to consider intrinsic farmer motivations and locational factors more comprehensively.

The work of Eichhorn et al. (2023) addresses the challenge of understanding factors that support or hinder the implementation of novel AECS, specifically result-based and collective schemes within the European Union. The research fills a gap in existing literature by systematically investigating the macro-environmental factors affecting the adoption of these novel schemes, moving beyond individual case studies and farmer surveys to a more holistic, structured analysis. The study thus posed research questions centered on the macro-environmental impacts on AECS adoption, employing a Political, Economic, Social, Technological, Legal, and Environmental (PESTLE) analysis framework. This approach provides a comprehensive method to categorize and understand the external factors affecting AECS. Data was collected through an online survey conducted in spring 2021 with 85 stakeholders from Austria and Germany, encompassing a broad range of participants involved in the design, implementation, and control of AECS, including government agencies, environmental organizations, and agricultural associations. The study's main findings reveal that economic, legal, and social factors are the most influential in the adoption of AECS, with economic incentives, clear legal frameworks, and social dynamics being pivotal. The unpredictability of nature was identified as a significant challenge for result-based schemes, whereas collective schemes emphasized the importance of social relations and farmer attitudes. Discussion within the study highlighted the nuanced implications of these factors on policy and practice, stressing the importance of addressing both external and internal influences on farmer decisions. The conclusions drawn suggest that the PESTLE approach effectively identifies critical factors influencing AECS adoption, providing strategic insights for policymakers and stakeholders. Looking forward, the study calls for further research into comparative analyses across countries, more in-depth investigations of differences between external factors for result-based and collective contracts and deeper examination of stakeholder influences.

The study of D'Alberto et al. (2023) goes back to an individual case-study analysis, but covers a broader scope of innovative contract solutions. Specifically, it investigates the perceptions of farmers in Emilia-Romagna, Italy, regarding four novel agri-environmental contract solutions, namely result-based (RB), collective (Co), value chain (VC), and land tenure with environmental clauses (LT). The study assesses farmers' perceptions of the understandability, applicability, and economic benefits of these contracts, as well as their willingness to enroll, using ordered logistic regression models that incorporate socio-demographic characteristics, structural features of the holdings, and preferences for 13 individual contract features. Key findings reveal that farmers' acceptance of innovative contract solutions is influenced by their age, with older farmers generally showing lower levels of acceptability and willingness to enroll. Previous experience with similar measures significantly affects farmers' perceptions, particularly enhancing the understandability of collective and value chain contracts. Structural characteristics of the holdings, such as exposure to trade channels, sales amount, and farm size, also play a crucial role in shaping perceptions of contract solutions. The study concludes that farmers are open to the investigated contract solutions, but acceptance varies based on individual and farm characteristics, necessitating careful consideration in policy design. For one, RB contracts are favored by organic producers and those involved in nature conservation, highlighting the importance of understanding and perceived applicability of result-based instruments. Co-contracts face opposition from larger farms due to

perceived inapplicability, but are welcomed by recipients of direct CAP payments. VC and LT contracts' attractiveness is strongly linked to farmers' previous experiences with similar measures, with a lack of such experience making these contracts seem complex and untrustworthy. VC contracts are moreover particularly attractive to farms already engaged in value chains, emphasizing the importance of understandability and applicability in these contexts. Overall, the study suggests that the successful implementation of improved contract solutions could be achieved through a flexible mix of instruments tailored to farmers' needs, incorporating a variety of contractual elements to enhance design and acceptance.

Finally, the paper of Bradfield et al. (2023) again carried out a cross-country analysis on innovative contract solutions. It evaluates the perceptions of land managers and stakeholders regarding the understandability, applicability, and economic benefits of four innovative agri-environmental contract types (results-based, collective action, value chain, and land tenure contracts) across twelve European countries, with a focused analysis on Ireland. The methodological approach entailed a survey of 2,275 land managers and 486 stakeholders. The Irish subset comprised 210 land managers and 16 stakeholders, highlighting the significance of agriculture in Ireland, where 72% of land is agriculturally used, the highest in the EU. Key findings indicate that most land managers agree that results-based contracts are understandable, applicable, and economically beneficial. However, there's a noticeable disparity in Ireland, with a lower proportion of land managers compared to other European countries agreeing that value chain and land tenure contracts are comprehensible and applicable to their farm. The study underscores the necessity for enhanced promotion and education concerning collective action contracts throughout Europe, emphasizing their critical role in public goods management. The conclusion suggests a pressing need for policies that offer financial certainty and autonomy to farmers, particularly in Ireland, to bolster the adoption of these innovative contracts. Furthermore, the study calls for increased practical exposure and education about these contract types to improve understanding and applicability, notably for collective action, value chain, and land tenure contracts which are less familiar to Irish land managers.

AUTHORS' CONTRIBUTION

The authors have contributed in equal parts to the development of the paper.

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Assessing the Landscape Recovery Scheme in the UK: a Q methodology study in Yorkshire, UK

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Abstract. Embedded within the European Union's Green Deal is a re-enforced scope to encourage farmers' participation in primarily voluntary agri-environmental schemes. Although outside of the European Union, the newly announced agri-environment schemes in England mirror such a policy shift towards incentivising participation in order to deliver more and better climate public goods. Farmers' viewpoints regarding such schemes and contracts are therefore important to examine, as they should be main determinants of current and future enrolment. In this paper, upland Yorkshire farmers were asked to express their opinions for the Landscape Recovery scheme that aims to encourage collaboration and achieve landscape-wide interventions to ensure lasting delivery of climate public goods. Viewpoints show divergent views between environmentally conscious farmers and pragmatic farmers objecting to the functioning of agri-environmental schemes. Farmer viewpoints lean towards 'broad and shallow' schemes that would have simple contract requirements and only achieve marginal gains in the delivery of agri-environmental climate public goods while still showing concern about the natural environment and its impact on farming.

Keywords: agri-environment schemes, Q methodology, Environment Land Management scheme, Landscape Recovery.
JEL codes: R58, R51, Q18.

1. INTRODUCTION

To carry out climate actions in the agricultural sector the European Commission has published its Green Deal aiming to utilise 40% of the Common Agricultural Policy budged for the 2021-2027 period for this purpose (European Commission, 2019). These climate actions include the "Farm to Fork" strategy (Scown et al., 2020) and incentivising participation to agri-environmental climate schemes (AECSs) through means of direct income and financial support (Hasler et al., 2022). The ultimate goal for the European Union's agriculture is to become carbon-neutral by 2050 (European Commission, 2019) and in the intermediary, devote 25% of its budget to eco-schemes (now part of the more heavily financed Pillar I of the new CAP) and link payments to mandatory environmental and biodiversity requirements of the new CAP period of 2023-2027 (European Commission, 2022).

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Participation in these (primarily) voluntary AECSs is determined by a variety of factors, including farmer characteristics (Unay Gailhard et al., 2015), motivations that include financial components (Lastra-Bravo, et al., 2015) and environmental inclinations (Dessart et al., 2019) and the scheme's characteristics (Tyllianakis and Martin-Ortega, 2021). Of particular interest when evaluating AECSs are determinants of farmer behaviour, driven by pre-existing concepts and viewpoints (Muhar et al., 2018). Empirical approaches to assess and find common patters in viewpoints regarding agriculture, environmental management and stewardship and types of AECSs are becoming more pronounced in the literature (e.g., Walder and Kantelhardt, 2018; Iofrida et al., 2018; Braito et al., 2020; Norris et al., 2021), recognising the important role that the plurality of viewpoints across a topic play.

This study aims to examine and analyse viewpoints concerning a soon-to-be introduced AECS in a country (England) that still is influenced by CAP concepts and has laid out ambitious environmental goals for AECS and the future of farming in the country. It aims to determine whether groups of farmers with similarities concerning their farm type and experience in collaborative AECS are positively inclined towards new and ambitious AECS currently rolled out in England. By using the semi-structured survey method of Q methodology I present the viewpoints of a specific, geographically-explicit group of UK farmers around the adoption of the newly introduced Landscape Recovery scheme. This is examined in a sample of Yorkshire farmers, members of the Countryside Stewardship Facilitation Fund (CSFF) scheme with past experience in collaborating and sharing knowledge around land stewardship. By doing so I find several patterns in viewpoints of upland farmers in Yorkshire, involved mainly in sheep and beef farming and depending on government subsidies for their income, regarding the operationalisation of the scheme in the lands they manage. I also identify two main typologies of drivers; practical and related to implementation concerns characterise one group of participants while social and environmental concerns are of interest in the other two groups. The paper next presents the method used and reviews past literature of relevance to this application (Section 2). Section 3 describes the case study locations while Section 4 describes the data collected. The results of the Q methodology are presented in Section 5 and Section 6 discusses the findings relating to the implementation of AECS and the delivery of agri-environmental climate goods in the UK and offers some concluding remarks relevant to policy-making.

2. LITERATURE REVIEW

The method of analysis chosen in this paper is Q methodology. It stems from the field of psychology and has seen a steady increase in its use through the years, starting from the mid-1950s (Stephenson, 1953) and recently has seen increased application in social sciences (Akhtar-Danesh et al., 2009). In its core, Q methodology systematically studies subjectivity on a particular topic (Brown, 1993) by identifying patterns within the discourse, as broadly and accurately as possible, of a particular topic (Doody et al., 2009). The researcher is responsible for presenting the full range of opinions in an activity and as such the approach is inherently subjective (Vecchio et al., 2022) and therefore more suitable to analyse attitudes towards a topic (Cross, 2005). Nevertheless, subjectivity is mediated by the researcher presenting recognised points of view to participants instead of an existing framework (Barker, 2008). Potential viewpoint patterns are analysed through factor analysis over small sample sizes (Davies and Hodge, 2007; Taheri et al., 2020). Of particular interest to researchers are patterns such as relationships between participants who have similar rankings of statements (i.e. similar attitudes) that represent the full discourse on a topic (Borthwick et al., 2003).

Q methodology has seen extensive application in surveys of farmers since the 1990's (e.g., van der Ploeg, 1992; Fairweather and Keating, 1994; Vanclay et al., 1998) and in particular post-2000 with farmers being the 5th largest group of stakeholders examined in the socio-environmental research literature employing the same methodology (Sneegas et al., 2021). Research amongst farmers is extremely rich and has focused on a plethora of issues. Such issues, for example, refer to determining generic views of farming (e.g., Fairweather and Keating, 1994), environmental management of agricultural land (Davies and Hodge, 2007) and farmers self-identity (Zagata, 2010). Identifying types of farmers based on viewpoints and beliefs is also of major interest in the literature which has focused on classifying farmers' identities (Cullen et al., 2020), farmers' ideologies or perspectives (Braito et al., 2020; Walder and Kantelhardt, 2018), farmer archetypes based on sociodemographic, psychological and structural characteristics (Leonhardt et al., 2022) or decision-making preferences related to the farm (Barbosa et al., 2020; Braito et al., 2020).

While studies focusing on environmentally conscious farming are more numerous, a small number of studies exists in the literature investigating the viewpoints of farmers regarding agri-environment schemes. Norris et al., (2021), for example, find that reliance on

ecosystems (peatland) determines one type of viewpoint while lack of land ownership makes participants more inclined to adopt pro-environmental behaviour. Visser et al., (2007) find that current use of a protected ecosystem in Ireland strongly influences differences in viewpoints between farmers and non-farmers regarding conservation approaches. Iofrida et al., (2018) report that farmers identify with concepts of modernising agricultural practices while emphasising the importance of protecting the environment in olive grove farming. Walder and Kantelhardt (2018) used a Q methodology approach to assess the views of Austrian farmers regarding specific agri-environmental schemes and found farmers' viewpoints combining environmental stewardship characteristics, appreciation of ecosystems as part of culture and placing less importance on generating income. Q methodology outcomes of types of farmers have also been used in quantitative studies to predict adoption of agri-environment schemes (e.g., Leonhardt et al., 2022).

3. CASE STUDY DESCRIPTION

This study focuses on two similar (in terms of farming activities and landscape) but also distinct CSFF groups in Yorkshire (in terms of size and financial and development opportunities in the wider area) of land managers. The study offers several insights into viewpoints for AECS, the role of farmer groups and facilitators and their impact. A sizeable portion of the (small) funds allocated to CSFF groups is assigned to fund the activities of a local group lead who can be either a farmer or a farm advisor. Such group leads are expected to encourage group participation, provide support in funding acquisition endeavours and training activities, amongst other duties. As a concept, collaborative groups of farmers, led by specific individuals can support "cultural and social capital" creation (Burton and Paragahawewa, 2011). Furthermore, established and well-functioning groups of land managers should influence implementation of AECS while reducing individualistic and un-coordinated approaches to farming (Riley et al., 2018), further strengthened by the role of intermediaries and advisors (Prager, 2015; Riley et al., 2018). As explained in the following sections, the two selected groups have been operating for several years, attracting an increasing number of engaged farmers, involved in several nature recovery and enhancement projects and steered by locally based group leads. Overall, these two groups should offer valuable insights when evaluating the Landscape Recovery scheme and inform potential uptake from such types of farmers.

3.1 Agri-environmental public goods post-Brexit in the UK

A UK case study is used, focusing on Yorkshire which contains large number of farmers, to examine the viewpoints on the innovative concepts the UK is introducing in its agri-environmental policy, with agri-environmental climate goods delivery being prioritised (Bateman and Balmford, 2018; Reed et al., 2020).

As the UK leaves the EU, increasing attention is being paid to the future design of national environment policy. Following the recent publication of the 25 Year Environment Plan and England's first Agriculture Bill for over 70 years (UK Parliament, 2020), the devolved administrations are consulting on and developing their own policies and strategies. In England's Agriculture Bill and the consultations run by each of the devolved administrations, proposals are being made to replace the current subsidy system of 'Direct Basic Payments' to farmers, which is based on the total area of land farmed, with a system based on "public money for public goods" (Defra, 2021a). There is therefore a unique opportunity to re-evaluate existing options and prioritise funding towards interventions that are more likely to deliver public goods.

As all existing direct basic payments are to be phased out over the Transition Period (2021-2028), (Defra, 2020). ELMs are being positioned to be the main source of future 'financial assistance' to UK's farmers. At the time of design of this study, ELMs were conceived by the Department of Environment, Food and Rural Affairs (Defra) as a three level system with varying degrees of complexity and environmental and biodiversity targets (Defra, 2020). The first level was broadly described to fund the 'broad and shallow' land activities through the Sustainable Farming Incentive (SFI), which will pay farmers for actions (Defra, 2021b), to continue supporting direct payments in farming. The other two levels are designed as being focused more on 'narrow and deep' AECS, under which farmers would be paid for outcomes (Defra, 2018) entailing higher demands from land managers, coupled with higher desired environmental results. These two highest levels were to include elements of collaboration, as well as different and increasing suggested means of monitoring of results and scope of deliver public goods. The Landscape Recovery scheme is the most ambitious of the ELM schemes, envisioning collaboration between land managers and landholders and landscape-wide interventions and benefits. A Test and Trials phase for trialling characteristics and goals of possible Landscape Recovery projects is taking place between 2021 and 2022, across England (Defra, 2021b).

3.2. Esk valley farmer group

The Esk Valley Countryside Stewardship Facilitation Fund (CSFF) network consists of a large group of upland and lowland farmers with common interests in improving water and soil quality within the Esk river catchment. Farmers have joined the group to explore ways of supporting their farm income through providing evidence of environmental services they already provide (carbon storage, natural flood management etc.) in the face of a changing domestic and European agricultural policy.

The CSFF is focused on the environmental and ecological aspects of the catchment, specifically from the perspective of those farming and managing the land (Defra, 2017). The CSFF aims to support efforts by the Esk Pearl Mussel and Salmon Recovery Project to reintroduce the Pearl Mussel to bolster the remnants of the existing population, through improving the water quality in the river. For this iconic species 'good' is not good enough, pristine conditions are required. This needs collective action from farmers in both upper and lower reaches of the catchment to reduce pollution and sedimentation problems (Defra, 2017). There is a long history of action in the River Esk catchment seeking to improve its ecological status so that an iconic species previously found in the river, the Freshwater Pearl Mussel, does not ultimately go extinct (Schaller et al., 2020).

The CSFF network covers the whole catchment and 30% of the land area (10,514 hectares, both in upper and lower reaches) is farmed by CSFF network members (59 members) (Defra, 2017). A key focus is what can be done to improve water quality across the catchment, especially as it is a salmon and trout river and sediment in the water is a major factor in the lack of recruitment of juvenile migratory fish (Defra, 2017). Water quality is generally good across the catchment and of Good Ecological Status according to the Water Framework Directive apart from one exception (Schaller et al., 2020). Many other additional environmental improvements have been added: sedimentation, nitrate and phosphate pollution due to the agricultural and farming activities in the area, and complement the main focus – for example waders benefit from the network tackling issues of water quality (Schaller et al., 2020). The majority of the land is under Good Ecological Status according to the Water Framework Directive while the pH is 6.0 for more than 68% of the Esk grasslands (compared to 53% for the whole of the U.K.) (Schaller et al., 2020).

The area encompassed by the Esk Valley CSFF is the Esk Catchment that extends from the source of the Esk all the way to the sea at Whitby (Defra, 2017). This means the catchment includes a range of land types from heather moorland to arable fields, areas classified as Site of Specific Scientific Interest (SSSI), Special Area of Conservation (SAC) and Special Protection Areas (SPA) to highly intensive farmland. There is little woodland in the region, less than 13% of the total region, mainly in linear strips (Schaller et al., 2020). As the area falls within the iconic National Park and its traditional landscapes so another aim is to address the disconnect between maintenance of these landscapes and the system to reward this. Farmers joined the CSFF with a two-fold intention: to see environmental improvements and economic benefits increase from the ongoing and expanding environmental management in the Esk catchment (Defra, 2017). The group and its activities were key in Esk Valley Farmers working with the National Parks Authority (NPA) to submit a successful bid for £300k of capital works plus advice programme (Schaller et al., 2020).

In terms of sociodemographic characteristics of the sample, the upper reaches there are moorland hill flocks of sheep and herds of beef cattle. Lower down in the valley dairy farms are seen; over time there has been a shift to smaller numbers of large dairy farms (Schaller et al., 2020). There are some small pockets of arable land in the valley and potatoes are typically grown. The farms tend to be small compared to the average size of farms in the Yorkshire Dales; the average farm size is about 100 hectares while there are 7-8 big dairy farms in the CSFF group. The farms are a mixture of owner-occupied and tenanted and this is mixed across the whole catchment. Farms belonging to the group cover approximately 1/3 of the whole Esk catchment (Defra, 2017). Large numbers of the farmers are reliant upon farm subsidies and agri-environmental scheme to stay in operation, and many of the farmers also have second jobs (Schaller et al., 2020).

3.3 South Pennines farmer group

The South Pennines Farmers CSFF network is a large network of farmers from the wider Yorkshire area benefiting from the support and active involvement of local government agencies aiming to bring farmers and land managers together, with support from governmental agencies to better deliver AECS. In particular, facilitate they facilitate knowledge exchange between farmers and provide information on how to better manage the local ecosystems especially under the threat of extreme weather events such as the damaging floods of 2015 (Defra, 2016). The group is comprised of a number of participants with homogeneous interests, land holdings and farm activities and farm holdings are found in mainly upland areas with the majority of the farmers

depending considerably on farm subsidies and AECS to supplement farm income (Schaller et al., 2020).

The South Pennines Farmers CSFF network was set up initially in 2015 with the purpose to deliver and explore how they can improve delivery of several key environmental benefits in the wider catchment area (Defra, 2016). Group members' land holdings are in the proximity of Special Protection Areas (SPA), Special Areas of Conservation (SAC) and the South Pennines Moor Site of Special Scientific Interest (SSSI), which is both expected to have beneficial impact on environmental quality of services and to be benefited from improvements in land management (Defra, 2016). Given the relatively high altitude (approximately 400m above sea level) of the land holdings the interest of farmers revolved around moorland restoration and enhancement, grassland habitat creation, and enhancing and expanding riparian habitats to benefit flood risk management and water quality while considering afforestation practices as well (Schaller et al., 2020). Soil quality and acidity result in grass quality not being enough for sheep to grow properly. Farmers in the group do not engage in any organized forestry and woodlands within the land holdings of members are currently unmanaged. It is early to see whether participation in the network and the actions it supports has produced tangible outcomes for the environment (Schaller et al., 2020).

The majority of the South Pennines Farmers CSFF network farmers have small holdings (average size is 30 hectares) and are involved in sheep and beef farming while there are no dairy farmers or arable/mixed farmers in the network either (Defra, 2016). Given the grass quality, sheep are being sold elsewhere for fattening which results in lower market prices for the local farmers. As a result, farmers have been engaging in other economic activities to supplement their farm income with the majority of network members having such "out-of-farm" income (Schaller et al., 2020). The low price of beef is also resulting in reduced farm income. Additionally, farmers in the area have been dependant in income from various environmental management schemes, mainly the Basic Payment Scheme (on average, 75% of farm income comes from payment schemes) (Schaller et al., 2020). The majority of the farms are not rented. From all farming activities in the wider Yorkshire area, the activities that the CSFF members partake (grazing livestock) is by far the least profitable one, generating £19.3k per year, lower than the England average (Defra, 2019). Grazing livestock in upland areas is the activity that the vast majority of farms in the West Yorkshire area (where the network's farmers are located) are engaged with.

Farmers in the group have seen a decline in farm income while intensification of weather events (such as the floods of 2015 and the recent (2019) floods that impacted West Yorkshire, in particular, with some lowland areas still recovering and undergoing rebuilding) stress the importance of proper land management in adjacent lands, making land abandonment a real future threat. Farmers see themselves, and are seen by other actors in the economy, as vital partners and providers to environmental goods and services that support climate change mitigation and adaptation while safeguarding income and lives. As a result, the grouping of farmers such as the specific CSFF network has allowed for the procurement of funding for a local council (Calderdale Council) to address flood issues and explore flooding measures such as Natural Flood Management (NFM), following the 2015 floods (Schaller et al., 2020).

4. DATA

4.1 Workshops

Two workshops took place in Yorkshire in March (Whitby) and May (Hebden Bridge) 2022. The Q-method was part of further data collection through questionnaires, data from which were not used in the analysis and they are not presented here. These questions assessed the knowledge of participants concerning Landscape Recovery and their interest in participating in agri-environmental schemes in general. They were followed by a list of open-ended questions where participants were asked about types of agri-environmental activities, their priorities regarding public good provisioning and how participants achieve farm production and delivery of public goods and finally assess any changes in knowledge and intentions to participate in agri-environment schemes.

The first workshop attracted 19 participants with all but two being farmers (the remaining participants were members of local government agencies and farmer advisors). The majority of the participants are quite active in participating in farmer meetings and only a small number of participants did not attend regularly farmer meetings organised in the general Whitby area or organised through the now-discontinued Esk valley CSFF group (which was comprised by a group of approximately 30 farmers). 14 complete Q-sorts were collected and analysed in the first workshop[1]. The second work-

[1] Questionnaire collection was fragmented with some participants not filling in the second questionnaire and with few not filling in them at all (also due to late arrivals). Some questions in the pre-workshop

shop attracted 15 participants, with all being farmers and members of the South Pennine Farmers CSFF group and regular attendees to farmer meetings and discussions through the years. This CSFF group reached a total number of approximately 60 members before it was discontinued but former participants still meet regularly and have contact with the group lead. Similar to the Esk valley CSFF group, the CSFF group of South Pennine farmers' legacy is the continued involvement of several of its members in aspects of land management in their area. Each meeting took approximately two hours in total to be completed. Only Q-sorts carried out individually were included in the analysis, Q-sorts that were completed collectively were excluded, as were Q-sorts from non-farmers. This approach was followed to ensure consistency in viewpoint expression.

4.2 Q methodology data

In order to understand better the viewpoints of land managers that participated in the two workshops, the Q methodology was used. Q methodology groups survey participants in distinct groups (sometimes called "factors") based on differences and similarities in their ranking of statements within a sample of statements, called the Q-set. After the participants rank-order the statements presented to them to their individual Q-sorts a quantitative analysis through factor analysis can take place (Taheri et al., 2020). Additionally, Q methodology allows for finding statements that participants had a consensus opinion on; either positive or negative one, and therefore are not part of the aforementioned groups of statements. Overall, Q methodology enables assessing common drivers and characteristics of survey participants for a specific topic. In this case, it allows to determine how opinions on contract, socio-economic, environmental and legal characteristics of Landscape Recovery groups Yorkshire upland land managers in distinct groups. Such statements need to be representative of the variety of opinions around the topic to allow for agreement and disagreement around them. See the next section for a detailed description of the Q-set formulation.

Following Sneegas et al. (2021)'s 'best practice' recommendations, below I present the development of the Q-set. To this end, a list of statements covering several aspects was produced through consultation with official documents describing the Landscape Recovery scheme, loosely based on a Political, Economic, Sociological, Technological, Legal and Environmental (PESTLE) analysis related to potential agri-environmental contract solutions between farmers from 13 case studies in Europe (Hamunen et al., 2022). Aspects considered relate to four different topics relating to AEPCSs: First, contract aspects (PO) (e.g., whether the 20-year length of Landscape Recovery is feasible for the participant, the availability of training as part of costs covered in the scheme, the requirement to collaborate with adjacent farms or whether compensation should cover income foregone etc.). Second, environmental aspects (EN) (e.g., scheme supporting climate change adaptation goals in the UK, scheme supporting wider delivery of public goods, etc.). Third, socio-economic implications of the scheme (EC and SO) (e.g., participation in the scheme reducing income uncertainty for farmers, scheme fitting different farm types and levels of income, scheme increasing the visibility and appreciation of farmers for delivering public goods etc.). Finally, policy-oriented aspects (LE and TE) (e.g., how well does the Landscape Recovery scheme fit with wider UK policy, how well the Landscape Recovery scheme fits with the participant's farm goals etc.). This resulted in 25 statements that were tested in a separate farmer workshop with 13 participants from north Yorkshire (including participants from the Esk valley and South Pennines CSFF groups) in February 2020. That workshop included a Q methodology and discussion afterwards on the statements and method itself. This helped to finalise phrasing and inclusion/exclusion of statements. The 22 final statements were then presented in the two workshops in the Esk valley and South Pennines in the form of laminated cards to participants, and they were asked to place them in a grid (turning the Q-set into a Q-sort). Statements placed in the extreme left were the ones that participants disagreed with most/did not interest them at all and those in the extreme right those with the opposite effect. The full list of the 22 statements is presented in Table 1. The Q-grid used is available in the Appendix.

Each Q-sort took participants approximately 20 minutes to complete. Q-sorts were then analysed through factor analysis, using a varimax rotation, using the statistical software Stata (version 15.1) and the *qfactor* command (Akhtar-Danesh, 2018). Statements were distinguished between each other with the Stephenson's (1978) formula that allows for an individual to be loaded on a factor of their score is statistically significantly different at the 95% level.

questionnaire were left unanswered from the farmers when some terms were not explained to them. For example, some questions in the pre-workshop questionnaire asked about ELMs Landscape Recovery but several farmers indicated that the workshop was the first time they heard about the term, and this was also one of their main reasons for attending and therefore more missing data exist.

Table 1. list of the Q-concourse items.

Statement	Coding
Contract Aspects (PO)	
Farmers' training and guidance should be eligible cost in the scheme	PO1
The scheme should deliver environmental goods and services by farmers, beyond biodiversity and carbon/climate benefits	PO2
Scheme must have a low level/amount of bureaucracy	PO3
Allow support from skilled authorities and intermediaries in aiding farmers in the implementation of schemes	PO4
Environmental aspects (EN)	
Adaptation to climate change (e.g. change practice/crops, irrigation systems) must be addressed by the scheme	EN1
Mitigation of climate change (e.g. reducing flood risk, sequestering carbon) must be addressed by the scheme	EN2
Scheme must take into account unpredictability of nature and the limited possibility for farmers to guarantee results	EN3
Scheme objectives acknowledge spatial and regional differences of environmental conditions across England	EN4
The contract of Landscape Recovery scheme should be 20 years or longer as there is a long period from action to result	EN5
Socio-economic (EC and SO)	
Financial compensation for participation in the scheme should follow cost incurred/income forgone	EC1
Landscape recovery should reduce financial risk and uncertainty of income for farmers	EC2
Scheme should support better visibility (appreciation, recognition) of farmers' work in providing environmental benefits	SO1
It is important for the scheme to support cooperation with others (stakeholders, neighbours, farmer unions)	SO2
Farmers' awareness and knowledge of environmental issues increases through participating in scheme	SO3
The Landscape Recovery fits all different farmer and farm characteristics: education, age, size of farm, tenancy	SO4
Policy (legal and technological aspects) (LE and TE)	
The ELMs and Landscape Recovery in particular, are simple to understand from the material online	LE1
Large scale landscape recovery is compatible with existing laws, programs and UK policy	LE2
The national Landscape Recovery goals are compatible with your farming long term goals	LE3
There is good agreement between Landscape Recovery priorities and practical, achievable goals in your region	LE4
Scheme must require SMART (Specific, Measurable, Attainable and action-oriented, Relevant, and Time-bound) indicators	TE1
Scheme must be easy to apply and without complex monitoring implementation	TE2
Farmers have no time or money for implementing measures in other ELMs on offer	TE3

5. RESULTS

In total, 25 Q-sorts were collected from the two workshops. After removing incomplete sorts (sorts where not all statements were placed within the grid, i.e., statements went missing) or Q-sorts that participants filled in in a collaborative manner, 16 Q-sorts were retained for analysis. Non-farmers were excluded from the analysis.

Results for a three-factor (discourse) solution can be seen in Table 2 below. 'Value' reflects the importance (from -4 to +4) an average participant loaded in a discourse placed on a specific statement. The three-factor solution explains 60% of the variance, higher than other Q methodology farmer studies (e.g., Iofrida et al., 2018) and was selected after comparing model fit with different number of factors and minimising consensus statements (Howard et al., 2016). Each of the three factors had an Eigen value higher than 2.8 and the three-factor solution had only two consensus statements compared to the 6 of the two-factor one. The higher the value participants in a factor placed on a statement, the higher the reported value in Table 2 below. Each Discourse had a similar number of Q-sorts loaded in it, with Q-sorts from Esk valley farmers loading mainly in Discourse 3 and 2 while Q-sorts from the South Pennines loaded equally in Discourse 1 and 2. The bottom of Table 2 presents statements (SO4 and LE3) that workshop participants had a consensus opinion on and as a result did not influence the grouping of participants in ether factor.

From the results of the Q methodology it appears that the workshop participants in Discourse 1 are concerned with practical, implementational characteristics when evaluating the prospect of enrolling in the Landscape Recovery scheme primarily, followed by environmental clauses embedded within the contract of the scheme. Offering training to farmers, guidance and support and economic returns are important to them. These "pragmatic yet environmentally conscious" workshop participants have slightly different priorities with those grouped in Factor 2 (Discourse 2). Workshop participants grouped in Discourse 2 are more preoccupied

Table 2. Relative importance for Landscape Recovery characteristics and aims for Esk and South Pennines land managers.

Discourse 1 (Factor 1)			Discourse 2 (Factor 2)			Discourse 3 (Factor 3)		
Pragmatic yet environmentally conscious			Pragmatic objectors			Risk-averse environmentalists		
Label	z-score	Value	Label	z-score	Value	Label	z-score	Value
PO1	1.860	4	PO1	1.62	4	EN1	1.61	4
PO2	1.120	3	EC2	1.6	3	TE2	1.22	3
SO3	1.580	3	PO3	1.42	3	EN2	1.22	3
EN1	1.050	2	TE1	1.04	2	EC2	1.21	2
EN3	0.927	2	PO4	1.19	2	SO2	1.16	2
EC1	0.617	1	SO3	0.339	1	PO1	-0.021	1
LE1	-0.025	1	EN3	0.229	1	SO3	0.516	1
LE3	0.091	1	LE3	0.279	1	EN3	0.041	1
SO2	0.678	1	TE2	0.62	1	SO1	0.902	1
TE1	0.461	1	EN2	-0.165	1	EN4	0.63	1
TE3	0.003	1	SO1	0.639	1	EC1	0.313	1
EC2	-0.145	0	EN1	-0.586	0	PO3	-0.085	0
EN4	-0.099	0	LE1	-0.371	0	TE1	-0.538	0
LE2	-0.206	0	TE3	-0.252	0	PO4	-0.449	0
PO3	-0.473	0	EN4	-0.374	0	LE3	-0.103	0
SO4	-0.513	0	SO4	-0.443	0	SO4	-0.372	0
TE2	-0.442	0	LE4	-0.378	0	LE4	-0.363	0
EN5	-0.649	-2	EC1	-0.92	-2	LE1	-1.17	-2
PO4	-0.961	-2	LE2	-0.708	-2	PO2	-0.83	-2
EN2	-1.480	-3	PO2	-1.49	-3	TE3	-1.3	-3
SO1	-1.110	-3	SO2	-1.31	-3	EN5	-1.7	-3
LE4	-2.290	-4	EN5	-1.98	-4	LE2	-1.91	-4
Number of Q-sorts= 5			Number of Q-sorts= 4			Number of Q-sorts= 4		
Consensus statements								
Label/Discourse 1			Discourse 2			Discourse 3		
SO4	1		1			0		
LE3	0		0			0		

with economic and implementational issues when considering enrolling in Landscape Recovery. In particular, these participants' viewpoints focus on the specifics of the scheme, in particular with respect to monitoring of results, low levels of bureaucracy and advice offered by skilled intermediaries. These "pragmatic" farmers appear less interested in environmental aspects of the scheme while being sceptical of how Landscape Recovery fits with their personal farming goals. Finally, participants' viewpoints in Discourse 3 showed a varied interest in environmental issues, compensation levels, minimising of financial and climate risk as goals of the scheme, as well as a desire to co-operate. These "risk-averse environmentalists" appear more interested in solutions that maximise farmers' income, training and welfare while minimising personal financial and climate-related risk. Such participants also appear to not find the Landscape Recovery's goals as attractive or feasible to them.

All groups of workshop participants appear to find the 20-year length of landscape Recovery as undesirable and consider the goals of Landscape Recovery as incompatible with existing UK laws. The results and ranking of statements (4 for "very important" to -4 for "not important at all") for each group of participants can be seen in Table 2. Workshop participants were in consensus regarding the uniformity of Landscape Recovery, either in terms of compatibility with personal farmer goals, or in terms of fitting all farmer types and profiles, as can be seen in the bottom part of Table 2. Both these statements did not differ significantly from discourse to

discourse and both were seen as "neither important nor important".

6. DISCUSSION AND CONCLUSIONS

The aim of the workshops was to understand the perspectives of upland Yorkshire farmers regarding the goals and intended impact of the Landscape Recovery scheme being rolled out in the UK. To achieve this the Q methodology was used and to demonstrate the range of viewpoints amongst farmers that share considerable similarities concerning their farming practices and dependency to government subsidies. The main outcome of the Q-sorting is that there is considerable agreement in viewpoints regarding the a) aspects of the scheme that are non-favourable for the participants and b) a desire to combine feasible and economically beneficial to their farm practices with environmental objectives. In particular, Discourses 1 and 3 ("Pragmatic yet environmentally conscious" and "Risk-averse environmentalists", respectively) group viewpoints that show interest in farmer-friendly AECS coupled with environmentally-friendly objectives. Economic returns and business-oriented viewpoints while showing a disposition towards AECS are grouped in Discourse 2 (as "pragmatic objectors" viewpoints), with such views being common in the literature (e.g., Davies and Hodge, 2007, Walder and Kandelheart, 2018; Norris et al., 2021).

Discourse 1 grouped statements somehow common issues affecting the practical enrolment of farmers to AECS. Such issues focus on simplifying implementation of AECS (PO2, +3) echoing similar studies (e.g., De Groot and Steg, 2010). Similar with other studies, such viewpoints are not "purely" from an environmentalist point of view (Norris et al., 2021) as farmers appear to want to combine financial viability of their farm (EN3, +2; EC1, +1). Viewpoints of such pragmatic yet environmentally conscious farmers appear more inclined to consider enrolling in an generic AECS contract as a means to achieve the two main goals (financial survival of the farm and environmental stewardship) but doing so through the Landscape Recovery scheme is strongly opposed to (LE4, -4). A desire for "broad and shallow" measures within AECS that achieve limited environmental benefits is often reported in qualitative studies amongst European farmers (Zimmermann and Britz, 2016; Braito et al., 2020). Within Discourse 1 also appear elements of a lack of desire to be recognized for their role as farmers (SO1, -3), contrary to Barbosa et al., (2020), potentially exacerbated by farmer views that the public underestimates the role of famers in society.

Discourse 2 has viewpoints focusing on contract-related characteristics of AECS such as adequate financial compensation provided to farmers (EC2, +4) (e.g., Walder and Kantelhardt, 2018), provisioning of advice being included in the scheme (PO1, +4) and reduced bureaucracy at the application stage and during the duration of the scheme (PO3, +3). These pragmatic farmers appear fundamentally against several AECS concepts such as the delivery of multiple agri-environmental public goods (PO2, -3), cooperate with other land managers (SO2, -3). This is confirmed by their belief that ELMs are not compatible with UK policy (LE2, -2). This reflects the wider literature concerning land managers' viewpoints regarding AECS contracts and their features, with current schemes failing to properly incentivise farmers to participate (Uthes and Matzdorf, 2013; Tyllianakis and Martin-Ortega, 2021). Such a desire for AECS with limited requirements is also confirmed in these pragmatic farmers by the strong viewpoints against the long-term duration (20-year) of contracts funded by the Landscape Recovery scheme (EN5, -4), similar with the risk-averse environmentalists in Discourse 3.

Discourse 3 ('risk-averse environmentalists') included viewpoints that are somewhat common in AECS since farmers are known to be generally risk-averse when considering AECS (Schroeder et al., 2013) while generally concerned about the environment grouped more environmentally-focused viewpoints, another common occurrence in the relevant literature (e.g., Walder and Kantelhardt, 2018; Braito et al., 2020; Cusworth, 2020). This discourse included viewpoints preferring simple AECS contracts over complicated ones with respect to monitoring (TE2, +3) and AECS acknowledging and being used to address the risk that climate change presents to farming (EN1, +4 and EN2, +3), showing preferences for "narrow and deep" schemes given their low preference for long contract durations (EN5, -3). This apparent pro-AECS stance coupled with strong objections to specific contract characteristics might indicate an extrinsically motivated approach of farmers (Matzdorf and Lorenz, 2010) when expressing viewpoints around the Landscape Recovery scheme

With respect to cultural capital creation in farming, evidence from the Q-sorting points to the need for training and guidance (PO1) as topic of agreement amongst most participants. Such a viewpoint, (evident in Discourse 1 and 3's viewpoints) reflects the need of farmers to receive training and guidance when enrolled in an AECS (Braito et al., 2020) but offering such an option might not be practically feasible in AECS contracts (Knierim et al., 2017). Given that viewpoints across the three farmer groups were indifferent for aspects of social

capital such as cooperation with other farmers (SO2) or having schemes that fit every farmer (SO4) came from participants of CSFF groups with well-functioning group leader dynamics. These groups had also operated over an extended period of time (each CSFF operates more than 5 years with the same group leader), nevertheless, cultural capital creation appears to be still be lacking. This prevents potential positive spillover effects in AECS (Burton and Paragahawewa, 2011) and in the delivery of agri-environmental climate goods. In other similar examples in the literature, Braito et al., (2020) did not find a desire amongst farmers to coordinate actions and foster social networks. Norris et al., (2021) did not find any association between membership in collective, cooperative agreements (what can be approximated by CSFF membership in the present study) and any farmer viewpoints when assessing viewpoints over peatland management between farmers. Therefore more studies are required to determine the impact that past experiences in cooperative, collaborative and socially-driven farmer networks influences similar viewpoints concerning environmental land management.

Limitations of this study refer to the research scope and the familiarity of participants with it. As it became evident through the workshops, many participants were not aware of the specific requirements and description of the Landscape Recovery scheme. Expressing their opinions was therefore based on past experiences and viewpoints concerning the authority responsible for the scheme' rollout (Defra) and their (limited) past experience with AECS. Therefore, larger 'burden of proof' is placed upon the workshop organisers to present an accurate description of Landscape Recovery to facilitate viewpoint formation. Additionally, some self-selection existed within the farmer sample. Interested farmers were more likely to respond to the invitation to participate in the workshops (although this should have been partially mitigated by the offer for claiming expenses and free dinner offered) and therefore their viewpoints might be representative of other, less engaged farmers. Therefore, generalising the findings is not possible (Walder and Kantelhardt, 2018) and also outside of the purposes of Q methodology (Norris et al., 2021). Finally, although farmer viewpoints are expected to be primary drivers behind enrolment in AECS, determining the impact that socio-demographic characteristics such as age, having a named successor, farmer income and current dependency from direct payments is required. All these factors were brought up from workshop participants as key drivers of any future enrolment in AECS, therefore quantitative experimental survey methods such as through the use of vignettes (e.g., Parkins e al., 2022) or examining relationships between observed AECS participation and farmer viewpoints/types (e.g., Leonhardt) could act as complimentary to the presented results.

From these findings, it appears that enrolling in the Landscape Recovery scheme is inhibited by a series of factors for upland Yorkshire farmers. Nevertheless, the viewpoints expressed by Yorkshire farmers should fit broadly with "broad and shallow" AECS (Defra, 2021), such as the wider ELM scheme. It appears that aspects regarding payments, free advice, duration and scope inhibit the endorsement of Landscape Recovery from Yorkshire farmers. Uncertainty around the level of payments, type of management practices and the type of changes in existing practices they would entail also appear significant. Furthermore, socio-environmental issues also further inhibit potential enrolment, with Landscape Recovery and particularly lengthy contracts within it, being perceived as un-aligned with Yorkshire farming goals and capabilities. Such findings, if corroborated by actual enrolment in Landscape Recovery in the future from upland beef and dairy farmers in Yorkshire, would mean that wider, landscape interventions will not be taking place in the area. Instead, such land managers would focus in less-demanding ELM schemes such as the SFI, which seems to be meeting the combination of requested management practices and involvement. Nevertheless, lack of clarity whether SFI payments would be enough to cover for the loss of Basic Payment Scheme (BPS) payments would mean that upland Yorkshire farmers might be faced with ever-decreasing farm-related income. In the event of this occurring, farmers are expected to turn even more to out-of-farm activities such as tourism and hospitality sectors to supplement farm income or continue the trend of land abandonment. This would have detrimental effects in maintaining the existing quality and quantity of public goods in the general Yorkshire area.

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APPENDIX

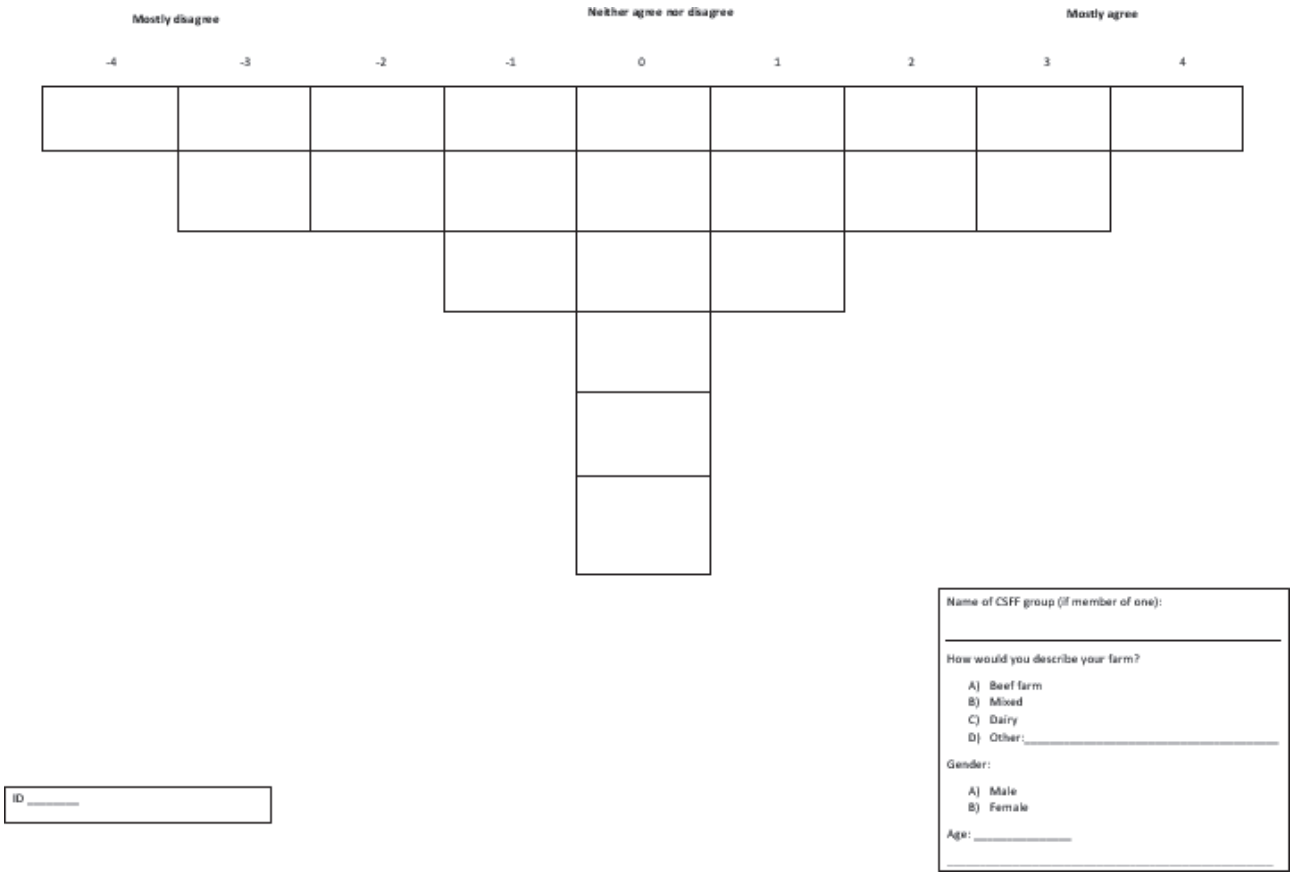

Figure 1. Q-grid used for sorting in the workshops.

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Upscaling environmental incentives in the Common Agricultural Policy: an assessment of the potential of transfers from the first to second pillar

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Abstract. Agri-environment-climate measures and organic farming support have been the main contractual instruments promoting environment-friendly agricultural practices in the European Union since the 90s. They are insufficient in reaching significant environmental improvements, partly because underfunded. Using French panel data from the farm accountancy data network, we evaluate the impact of a budget transfer from income support to environmental incentives on contract uptake. We apply a generalised Tobit model to estimate the adoption probability and the acceptable farm-level payment triggering this adoption and simulate a transfer from direct payments to organic farming support and agri-environment-climate measures budget. Results suggest this mechanism increases adoption. Decreasing direct payments affects participation probabilities and acceptable farm-level payments, differently depending on the type of environmental contract, the type of direct payment and the farm technical orientation. We evaluate several transfer scenarios and provide ex-ante elements on how it could help reaching the Green Deal organic target.

Keywords: common agricultural policy, Tobit model, agri-environment-climate measures, organic farming support.
JEL codes: Q15, Q18, Q58.

1. INTRODUCTION

The agricultural sector accounted for 10% of the European Union's (EU) greenhouse gas (GHG) emissions for the period 1990 to 2018 and is the second largest contributor after the energy sector (EEA, 2020). The continuous intensification of agricultural activities also contributed to natural habitat degradation and dramatic biodiversity decline (Dasgupta, 2021). Behind the concept of agroecological transition lies the idea of moving away from agri-

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cultural practices harming ecosystem services, in particular the systematic use of chemical inputs, towards farming systems maintaining or supporting them (Millennium Ecosystem Assessment, 2005). The EU adopted ambitious environmental targets by 2030 and 2050, in particular on the development of organic farming (OF) to reach 25% of organic agricultural land by 2030. Many levers at various scales can foster this transition. An important one is better targeting agricultural support to make agroecological farming more profitable than conventional farming (FAO et al. , 2021). The Common Agricultural Policy (CAP) represented 36% of the 2019 EU's budget (58.4 billion euros) (EC, 2019) and is the main EU policy supporting environment-friendly farming practices (Coderoni, 2023). The CAP budget allocated to environmental commitments is low in comparison to income support payments (direct payments of the "first" CAP pillar), the latter including little restrictions on agricultural practices (Dupraz and Guyomard, 2019; European Court of Auditors, 2017; Grethe et al., 2018; Matthews, 2013). Following the definition of the Biodiversity Strategy for 2030 and the Farm to Fork Strategy for the agricultural and food sectors, rethinking the design of the CAP and its instruments is central to triggering the large-scale agroecological transition of farming systems (EC, 2020a, 2020c).

In this study, we develop a farm-based modelling framework to assess a reorientation of the direct payments budget specifically towards environmental contracts in France. In the 2014-2020 CAP programming period, environmental incentives were offered in two voluntary 5-year contractual schemes of the rural development pillar ("second" pillar) of the CAP: (i) support to OF, and (ii) agri-environment-climate measures (AECM). OF support are area-based payments to eligible farms undertaking a conversion towards OF, or to eligible certified organic farms for maintaining their organic practices. AECM are area-based payments to eligible farms complying with a set of management requirements targeting an environmental objective such as the maintenance of biodiversity or the improvement of water quality. OF support has proven to be effective in maintaining the relative competitiveness of OF and is a major driver of the sector development (Casolani et al., 2021; Sanders et al., 2011), while AECM are the CAP instruments the most targeted towards public good provision (Batáry et al., 2015; Dupraz and Guyomard, 2019; European Court of Auditors, 2020; Matthews, 2013). In 2019, direct payments accounted for 69% of the CAP budget (40.5 billion euros), while 8.6% (3.5 billion euros) was allocated to OF support, AECM and Natura 2000 sites altogether (EC, 2019). The literature shows that after 30 years of existence, the voluntary environmental schemes of the CAP were unsatisfactory to improve the state of the environment. The lack and unbalanced funding, as well as poorly designed instruments, led to insufficient participation and effort to reach environmental thresholds (Dupraz et al., 2009; Dupraz and Pech, 2007; Espinosa-Goded et al., 2013; Targetti et al., 2022; Zavalloni et al., 2019). In 2020, only 13% of the EU's UAA was under an AECM contract, and 6% under an OF support contract (EC, 2020b, 2020d). Rather than increasing the policy budget to raise environmental incentives, many argued in favour of rebalancing the budget allocation among the various CAP instruments (Dupraz and Guyomard, 2019; Matthews, 2013). Since the 2014-2020 CAP programming period, Member States have the flexibility to transfer up to 15% of their direct payments budget to increase support to rural development measures, including OF support and AECM (EU, 2013). In France, 7.5% of direct payments have been redirected since 2017 (MAA, 2021). For the 2023-2027 CAP programming period, it has been decided to dedicate 25% of the direct payments budget to finance a new instrument (eco-schemes) open to all farmers and supporting the voluntary implementation of environment-friendly measures (generally less ambitious than OF support or AECM contract requirements) (EC, 2021; Runge et al., 2022). Although the negotiations ruled out this option, dedicating a higher share of the CAP budget to finance more OF support and AECM was another potential (complementary) lever to upscale environmental incentives and was preliminarily evaluated by (Chatellier et al., 2021).

In this paper, we estimate an environmental contract adoption model with observed panel data from the French farm accountancy data network (FADN). We propose a generalised Tobit model estimating the adoption decision and the minimum farm-level payment triggering adoption ("acceptable" farm-level payment). We develop a simulation approach to predict the impact of a budget transfer from direct payments towards the implemented environmental contracts during the 2014-2020 CAP programming period: support to OF and AECM. Simulating a budget neutral transfer under ceteris paribus conditions, we decrease the direct payments received by farmers and increase the environmental payments to be distributed to OF support and AECM adopters. Our farm-based model estimates are used to predict a new contract uptake outcome in 2019. Our framework does not integrate the market effects of the simulated budget transfers. It means that we assume that induced farm input and output price changes are negligible.

We find that the transfer of an additional 7.5% (reaching the maximum transfer rate of 15% between

the two CAP pillars) of direct payments towards AECM and OF support results in an increase of participation in AECM from 11% to 23%, and in OF support from 7% to 15%. The predicted participation rate and UAA under environmental contracts increase linearly with the budget transfer rate simulated. Our model suggests that an additional transfer rate of 15.5% to reach 23% of transfer between the two pillars would allow to reach the Green Deal target of 25% of organic UAA. We observe an indirect effect on farmers' behaviour of decreasing direct payments. In particular, the probability of participating in AECM significantly increases with the amount of coupled payments for suckler cows received at the farm level (+0.1% per 1,000€). We also estimate a strong positive effect of decoupled direct payments on OF support acceptable farm-level payments (+1,039€ per 100€/ha), such that our model predicts that farms participate in OF support for lower farm-level payments after the budget transfer. We identify a differentiated impact of the budget transfer according to the type of farm, with an increased incentive for farms specialised in grazing livestock to contract AECM, and for farms specialised in cereal and field crops, permanent crops, dairy, pigs and poultry or mixed farming with field crops and grazing livestock to contract OF support.

Our first contribution is an ex-ante evaluation method of the transfer mechanism from direct payments to environmental contracts. In particular, we model the impact on adoption. To our knowledge, the effect of such a budget transfer has not yet been assessed at the farm level and for an allocation targeting environmental contracts specifically. Previous ex-ante evaluations of the reorientation of direct payments used the CAPRI (Common Agricultural Policy Regionalised Impact) partial equilibrium model (Himics et al., 2020; Schroeder, 2021; Schroeder et al., 2015), or linear programming (Giannakis et al., 2014), to study the impact on environmental indicators aggregated for farm types and EU regions. Hence, it remains unsure how effective it can be to significantly increase the voluntary adoption of environment-friendly practices at the farm level, and what are the underlying microeconomic mechanisms. Adoption results from the confrontation of the supply of environmental commitments by farmers (farm and farmer characteristics, opportunity costs), and the demand from public authorities (budget, eligibility criteria, technical requirements, payment). Our model partly overcomes the absence of information on the diversity of contract characteristics and eligibility rules by controlling for many factors of farm heterogeneity.

Our second contribution is to capture the effect of direct payments on both the environmental contract adoption decision and the associated acceptable farm-level payment in France under the 2014-2020 CAP framework. Beyond a direct positive effect on the participation of an increased budget available to finance environmental contracts, one can expect an indirect effect of the transfer on farmers' response to environmental incentives, resulting from the decrease of direct payments (lower income support). Monetary aspects from different sources, including direct payments, are important drivers of the decision to adopt AECM and OF (Darnhofer et al., 2019; Jaime et al., 2016; Sanders et al., 2011; Van Herzele et al., 2013). Allaire et al. (2011) and Pufahl and Weiss (2009) found different effects of direct payments coupled to production on participation in AECM, with an overall positive effect in Germany, and a marginal or negative effect in France for extensive grassland measures. Moreover, a positive effect of the decoupling of direct payments on the adoption of OF was found in Sweden (Jaime et al., 2016). This literature proved that both direct payments and environmental payments affect the decision to adopt environment-friendly practices, showing the importance of considering direct and indirect effects when evaluating the potential of a budget transfer in boosting more adoption. In our study, we complement previous studies by looking at the effect of direct payments on not only the adoption decision, but also the amount of payment to allocate to farms to trigger this adoption.

The paper is organised as follows. Section 2 presents the data, theoretical framework and econometric model of environmental contract adoption, and the procedure to simulate a reorientation of the CAP budget. Section 3 describes the estimated econometric models and presents the predicted results. Section 4 discusses the methodological approach and the findings. Finally, section 5 draws some conclusions.

2. MATERIALS AND METHODS

Our methodological approach to simulate a change of CAP budget allocation comprises three steps:

1. Estimation of the model of voluntary contract adoption under the current budget allocation.
2. Prediction of new probabilities and acceptable farm-level payments with a reduction of direct payments.
3. Starting from the farm with the highest probability to participate, allocation of the initial instrument budget plus an additional amount from the direct payments budget to participants, up to their estimated acceptable farm-level payment, until the budget is exhausted.

In this section, we present how we applied this methodological approach using observed French data from the 2014-2020 CAP programming period with two types of environmental contracts: OF support and AECM.

2.1 Data

The French Metropole FADN data for the years 2015 to 2019 were used in the study. The data represent an unbalanced panel of 36,251 farm observations and include information on the total farm-level payment (€) received for AECM contracts on the one hand, and OF support contracts on the other hand. The dataset does not include information on the surfaces enrolled in each contract type, nor on the specific measures adopted, but knowing the organic certification and organic conversion status of the farms allows us to identify whether a recipient of OF support has a conversion OF support contract or maintenance OF support contract. The national FADN is designed to be representative of medium and large farms contributing to more than 90% of the gross production and utilised agricultural area (UAA) and covers the scope of 65% of all farms (Agreste, 2022). This data source is therefore particularly relevant for ex-ante CAP evaluations.

From 2015 to 2019, a total of around 1.6 billion was allocated to the farms of our FADN sample for engaging in AECM and OF support (Table 1). The highest budget was for 2019, with 228 million € to 11% of sample farms for AECM, 66 million € to 1.5% of sample farms for conversion OF support and 138 million € to 5% of sample farms for maintenance OF support. For that same year (2019), the French Government reported allocating a total of 244 million € for AECM, 191 million € for conversion OF support and 58 million € for maintenance OF support (DDT Ariège, 2020). In terms of participation rate, it corresponds to around 11% of metropolitan farms having contracted an AECM, 5% conversion OF support and 3% maintenance OF support (DDT Ariège, 2020; INSEE, 2022). Hence, the FADN sample describes the allocation of 93% of the

Table 1. Common Agricultural Policy budget and beneficiaries in 2015-2019[1].

Year	Direct payments	Decoupled direct payments	Coupled direct payments for suckler cows	AECM	OF support	Conversion OF support	Maintenance OF support
Budget (million €)[2]							
2015	7,288.4	6,095.6	667.5	165.3	122.5	23.6	99.0
2016	6,955.9	5,781.6	631.5	136.5	123.5	18.7	104.8
2017	7,124.9	5,880.6	651.6	159.4	140.0	19.4	120.6
2018	6,727.5	5,576.2	623.7	189.7	147.2	30.6	116.6
2019	6,676.0	5,561.1	655.0	227.9	203.3	65.7	137.6
Beneficiary farms (%)							
2015	85.7	84.1	24.9	6.2	5.6	0.9	4.7
2016	85.5	84.2	25.2	6.6	5.8	0.7	5.1
2017	85.1	83.6	25.9	7.8	5.6	0.6	5.0
2018	85.6	84.4	25.8	8.9	5.3	0.8	4.5
2019	85.3	84.1	26.5	10.8	6.9	1.5	5.4
Beneficiaries' UAA (%)							
2015	97.9	97.3	34.0	8.8	4.2	0.8	3.5
2016	98.4	98.1	34.1	9.1	4.4	0.7	3.8
2017	98.4	98.0	35.3	10.3	4.9	0.5	4.3
2018	98.4	98.1	35.0	11.9	4.9	0.9	4.0
2019	98.6	98.1	35.8	14.5	6.3	1.6	4.7

AECM: agri-environment-climate measures. OF: organic farming.

[1] All figures are weighted by the extrapolation coefficient of each observation.

[2] To compute the total policy instrument budget for year t, we corrected for delayed payments distributed at year t+1 or t+2. Less than 0.2% of the direct payments were distributed at t+1 for 2015, 2016, 2017, 2018 and 2019, and at t+2 for 2015 and 2017. Less than 8.0% of the AECM and OF support payments were distributed at t+1 for 2018 and 2019. We could not correct for 2019 instrument budgets distributed in 2021 (data not available at the time of the study).

Source: 2015-2020 French FADN data.

AECM budget and 82% of the OF support budget to a representative ratio of participants/non-participants in 2019. However, it does not represent well the repartition between conversion OF support and maintenance OF support and overestimates the allocation of OF support to certified farms relative to farms in conversion. Yet, we observed the ratio within the OF support eligible population (i.e. farms converting to OF or already certified in 2019) is well represented in the FADN, at least when it comes to the utilised agricultural area (UAA) (see Appendix A1) (Agence bio, 2020).

2.2 Theoretical model of voluntary adoption of an environmental contract

For a given type of environmental contract (AECM on the one hand, and OF support on the other hand), we represent the demand for environmental commitments from authorities during a CAP programming period by a function $\theta(M,B,\Gamma)$ describing a set of measures M (the diversity of technical requirements belonging to the contract type), a total budget B, and policy parameters Γ defining exclusion rules. For OF support contracts, M includes a diversity of measures designed for specific land use, and either for *maintaining* organic practices (maintenance OF support) or for *converting* to organic practices (conversion OF support). For AECM contracts, M includes a diversity of measures designed for a specific land use and generally an environmental target (water quality, biodiversity…). In France, not all farmers are eligible to AECM contracts and maintenance OF support contracts. The exclusion rules are based on the location of the farm and described by Γ. The confrontation of demand and supply of environmental commitments results in an uptake equilibrium such that $B=\Sigma_i P_i(M,\Gamma_i,a_i,k_i,e_i)$. With P_i the farm-level payment allocated to farms, Γ_i whether the farm is eligible to the environmental contract type (location in the eligible area), a_i the farm characteristics affecting eligibility to a subset of environmental measures of M (location, land use, organic certification status…), k_i other farm and farmer characteristics (economic size, surface, age, education, technical orientation…), and e_i the farm economic context (market prices, CAP support, etc).

We assume the supply of environmental commitments by farmers is driven by the profitability of adoption and eligibility. In practice, the payment for an environmental contract is delivered as a payment per hectare enrolled, and for most measures, the farmer can decide to enrol all or part of his/her farmland. However, the binary adoption decision (participation vs. no participation) is made at the farm level. Therefore, we assume the farmer decides based on whether the total farm-level payment received for enrolling his/her profit-maximising amount of farmland in an environmental contract is sufficient to make participation profitable. The decision $D_i^\star$ of farmer i to participate and the binary participation D_i are defined as follows:

$$D_i = \begin{cases} 1 \; if \; D_i^* \geq 0 \\ 0 \; otherwise \end{cases} ; \; D_i^*(M,\Gamma_i,a_i,k_i,e_i) = \Phi_i(m_i^*,\Gamma_i,a_i,k_i,e_i) - P_i^*(m_i^*,a_i,k_i,e_i) \quad (1)$$

With $m_i^\star \in M$ the characteristics of the measure(s) adopted by the farm (technical requirements, payment per hectare), $\Phi_i \geq 0$ the maximum farm-level payment the farm is eligible to for adopting $m_i^\star$ on all eligible surfaces, and $P_i^\star > 0$ the minimum farm-level payment triggering the adoption of $m_i^\star$ (acceptable farm-level payment) by the farmer. $m_i^\star = m_i^\star(M,\Gamma_i,a_i,k_i,e_i)$ is the optimal contract uptake and the solution to the profit maximisation programme of farm i. If $\forall m_i \in M, \Phi_i(m_i,\Gamma_i,a_i,k_i,e_i)=0$ or $0<\Phi_i(m_i,\Gamma_i,a_i,k_i,e_i)<P_i^\star(m_i,a_i,k_i,e_i)$ (the farmer is not eligible or participation is not profitable for any contract), then $D_i^\star<0$ and the farm is not participating. If $\exists m_i \in M, \Phi_i(m_i,\Gamma_i,a_i,k_i,e_i) \geq P_i\,(m_i,a_i,k_i,e_i)$, the farmer is eligible to at least one contract profitable for him or her, and the farmer decides to participate with the optimal contract uptake $m_i^\star$ such that $D_i^\star \geq 0$. Φ_i represents the constraint of demand for environmental commitments faced by the farmer (the maximum payment public authorities are willing to allocate for adopting an environmental contract), while $P_i^\star$ represents the constraint of supply (opportunity costs of conventional farming and farm size). In this setting, the farm-level payment allocated to farms P_i is:

$$P_i(M,\Gamma_i,a_i,k_i,e_i) = \begin{cases} P_i^*(m_i^*(M,\Gamma_i,a_i,k_i,e_i)\,,k_i,e_i) \; if \; D_i^*(M,\Gamma_i,a_i,k_i,e_i) \geq 0 \\ 0 \; otherwise \end{cases} \quad (2)$$

2.3 Empirical model of voluntary adoption of an environmental contract

Following the theoretical framework, we aim to estimate a model of adoption of environmental contracts during a CAP programming period proposing the menu of measures M. Due to the censored nature of the farm-level payment, an estimation of the acceptable farm-level payment with least squares methods is not applicable. We apply a generalised Tobit model (Amemiya, 1984; Wooldridge, 2010) to simultaneously estimate two dependent variables: the decision to participate (selec-

tion equation) and the acceptable farm-level payment (outcome equation), as functions of observed determinants from a sample of participants and non-participants. We estimate one model for each type of environmental contract: OF support and AECM. While both contract types require the implementation of low-input environment-friendly practices, the implications on the farm business are different. On the one hand, adopting an OF support contract is associated with the prospect of obtaining or maintaining the organic certification of the farm and accessing the organic market in the long term. It also often implies implementing organic practices on all the farmland. On the other hand, adopting an AECM is associated with a medium-term commitment to low-input farming, and for most measures, on a flexible share of the farmland. For at least those two reasons, it appears relevant to consider that the decision-making process as well as the acceptable farm-level payment triggering the profitability of adoption differ between AECM and OF support.

With panel data, the decision to participate of farmer i in year t is represented by the latent variable $D_{it}^{\star}$ explained by observed covariates $Z_{it}=(a_i,k_{it},e_{it})$ defined in the following paragraphs, environmental contract exclusion criteria Γ_{it} and an error term ε_{it}. To control for individual fixed effects, we rely on the Chamberlain-Mundlak device and control for the individual mean of the subset of time-varying covariates $\overline{Z}_{\iota}$ (Mundlak, 1978; Wooldridge, 2010). α, γ, ξ and ι are the intercept and vectors of parameters to be estimated. The observed participation can be described by a binary random variable $D_{it}=\{0,1\}$ (Equation (3)).

$$D_{it}^{*} = \alpha + \gamma Z_{it} + \xi\Gamma_i + \iota\overline{Z}_{\iota} + \varepsilon_{it},\ \ \varepsilon_{it}\sim N(0,1),$$
$$D_{it} = \begin{cases} 1\ if\ D_{it}^{*} \geq 0 \\ 0\ otherwise \end{cases} \quad (3)$$

Our outcome of interest is the acceptable farm-level payment $P_{it}^{\star}$ triggering participation, which is explained by the observed covariates $Z_{it}=(a_i,k_{it},e_{it})$, environmental contract exclusion criteria Γ_i, the individual mean of the subset of time-varying covariates $\overline{Z}_{\iota}$ and an error term u_{it} (Equation (4)). β, δ, η and κ are the intercept and vectors of parameters to be estimated. For identification, the outcome equation must include one less explanatory variable than the selection equation. The total farm-level payment P_{it} received by farm i at year t is observed in the data and is only different from zero for participating farms (censored variable at zero).

$$P_{it}^{*} = \beta + \delta Z_{it} + \eta\Gamma_i + \kappa Z_{\iota} + u_{it},\ \ u_{it}\sim N(0,\sigma^2),$$
$$P_{it} = \begin{cases} P_{it}^{*}\ if\ D_{it}^{*} \geq 0 \\ 0\ otherwise \end{cases} \quad (4)$$

Based on the literature on the factors affecting AECM and OF adoption and our theoretical approach (Allaire et al., 2011; Defrancesco et al., 2008; Elliott and Image, 2018; Espinosa-Goded et al., 2013; Pavlis et al., 2016), we selected a set of variables to model contract uptake.

Explanatory variables were included to control for factors of eligibility to the diversity of environmental measures (a_{it}) of the set M defined by public authorities in the CAP 2014-2020 programming period. We include one dummy variable equal to 1 if the farm is certified organic (*organic certification*). Controlling for organic certification captures the effect of eligibility to maintenance OF support or conversion OF support, as only certified organic farms can apply to the former. Moreover, most AECM contracts are designed specifically for some land use and areas with high natural value. We control for the share of permanent grasslands in the UAA (*permanent grasslands*), and the load of grazing livestock per hectare (*grazing livestock density*). We add a dummy equal to 1 if half of the farm's UAA is located in a Natura2000 area (*Natura2000*).

Accounting for farm and farmer characteristics (k_{it}) captures heterogeneous difficulties in meeting contract requirements and preferences. We control for economic size (*standard gross production*), UAA (*utilised agricultural area*), total labour per hectare of UAA (*labour*), the share of rented land (*rented UAA*), assets depreciation per hectare of UAA (*depreciation*) and for the reception of LFA payment (*LFA*). We account for farm specialisation (1 dummy per technical orientation or group of technical orientations). Farmer's characteristics are age (*age*) and education (*general education* and *agricultural education*). In addition, we control for past participation. To do that we estimate the adoption models with 2016-2019 data (28,967 observations) and use 2015 data to construct a variable equal to 1 if the farm already adopted the environmental contract in 2015, and 0 otherwise (*observed participation in AECM in 2015* and *observed participation in OF support in 2015*). In addition, we capture part of the interaction between OF support and AECM uptake by controlling for observed participation in AECM (OF support respectively) at time *t*-1 when estimating the decision to participate in OF support at time *t* (AECM respectively) (*observed participation in AECM at t-1* and *observed participation in OF support at t-1*). For model identification, we exclude this variable from the simultaneous outcome equation. As we have unbalanced panel data, it has to be noted that information on past participation is missing for observations that were not sampled the year before.

Regarding the farm economic context (e_{it}), we control for the effect of CAP direct payments by including the amount of decoupled direct payments received per hectare of UAA (*decoupled payment*). We control the amount of direct payments for suckler cows at the farm level (*coupled payment for suckler cows*) as it is the production receiving the highest coupled support in France. We further control for the cost of land lease per hectare of UAA (*land lease*), and the observed fuel and lubricant price of the farm (*fuel price*), the only variable input price that can be computed with FADN data. Fuel price is likely correlated to other farm input prices on the market (mineral fertilisers), and is an indicator of opportunity costs from adopting less input-intensive agricultural practices. When fuel price is not observed for a given observation (8.4% of the sample), we replace it with the mean of the observed fuel prices from the other years for the same farm (3.3% of the sample), or the annual mean of the sample (5.1% of the sample).

Explanatory variables were included as part of Γ_i to characterise eligibility to the environmental contract types defined by public authorities in the CAP 2014-2020 programming period. Maintenance OF support eligibility depends on the region, with some not proposing those contracts in all or part of their territory after 2017. We therefore account for farm location (1 dummy variable per region) in the model. In practice, location criteria Γ_i also prevent some farms from participating in AECM based on their location. In particular, only farms located in an agri-environment-climate project (with a geographical scale smaller than the region) are eligible. We do not have enough information in the FADN to identify and exclude non-eligible farms in the case of AECM. Without information to characterise the exclusion criteria Γ_{it}, the actual model estimated for AECM is the following one:

$$D_{it}^{*} = \alpha + \gamma Z_{it} + \iota \overline{Z}_{\iota} + v_{it}, \;\; v_{it} \sim N(0,1),$$
$$D_{it} = \begin{cases} 1 \; if \; D_{it}^{*} \geq 0 \\ 0 \; otherwise \end{cases} \quad (5)$$

$$P_{it}^{*} = \beta + \delta Z_{it} + \kappa Z_{\iota} + w_{it}, \;\; w_{it} \sim N(0, \sigma^2),$$
$$P_{it} = \begin{cases} P_{it}^{*} \; if \; D_{it}^{*} \geq 0 \\ 0 \; otherwise \end{cases} \quad (6)$$

With v_{it} and w_{it} the error terms. We have an omitted-variable bias on γ equals to $\xi \frac{Cov(Z_{it},\Gamma_i)}{Var(Z_{it})}$ in Equation (5) and on δ equals to $\eta \frac{Cov(Z_{it},\Gamma_i)}{Var(Z_{it})}$ in Equation (6).

Descriptive statistics of the covariates are presented in Table 2 and Appendix A2.

The latent continuous variable D_{it}^{*} is estimated with a Probit regression model with the binary variable D_{it} as dependent variable over the sample of participants and non-participants. The acceptable farm-level payment is estimated for each farm of the sample based on the estimation of the outcome equation using the participating farms. We control for year-fixed effects with dummy variables. The individual mean of the time-varying variables $\overline{Z}_{\iota}$ controlling for individual-fixed effects are all the covariates included in Z_i but location in a less favoured or Natura2000 area, age, education, farm specialisation, the region, and observed participation in AECM or OF support in 2015. We also include the individual mean of the time dummies because we have an unbalanced panel (Wooldridge, 2019). We do not impose an upper limit to the estimated acceptable farm-level payments to capture the behaviour of farmers requiring a strong financial

Table 2. Descriptive statistics of the 2016-2019 FADN sample used for the estimations (N=28,967)[1].

	Mean	Standard deviation[2]
Dependent variables		
Participation in AECM	0.09	-
Participation in OF support	0.06	-
AECM payment (€) (D=1)	7,129.68	6,691.92
OF support payment (€) (D=1)	8,834.07	9,752.82
Independent variables		
Decoupled payment (€/ha)	193.42	379.42
Coupled payment for suckler cows (€)	2,179.01	4,552.01
Land lease (€/ha)	650.72	3,278.06
Fuel price (€/l)	0.63	0.12
Standard gross production (€)	173,838.99	194,712.41
Utilised agricultural area (ha)	89.14	76.73
Labour (AWU/ha)	0.24	3.23
Share of rented area	0.73	0.36
Depreciation (€/ha)	2,006.75	34,780.83
LFA	0.28	-
Age (years)	51.08	9.58
Share of permanent grasslands	0.22	0.31
Grazing livestock density (LU/ha)	0.55	1.17
Natura2000 area	0.04	-
Certified organic	0.08	-
Observed participation in AECM in 2015	0.05	-
Observed participation in OF support in 2015	0.04	-
Observed participation in AECM at t-1	0.07	-
Observed participation in OF support at t-1	0.05	-

AECM: Agri-Environment-Climate Measure. OF: Organic Farming. AWU: Annual Work Unit. LFA: Less Favoured Area. LU: Livestock Unit.

[1] All figures are weighted by the extrapolation coefficient of each observation.

[2] Standard deviations are reported for the non-dichotomous variables.

Source: 2015-2019 French FADN.

incentive to participate. We impose acceptable farm-level payments that cannot be lower than 300€, which is the minimum required by French public authorities to start a contract (MAA, 2020).

The Tobit regression model provides estimated coefficients of the effect of the explanatory variables on both the decision to participate in an environmental contract and the acceptable farm-level payment triggering participation, as well as the correlation ρ of the error terms of the two equations. The marginal effects of each variable are computed at sample means so that coefficients can be more easily interpreted.

2.4 Simulation of CAP budget transfer

We predict the impact on contract uptake of increasing the budget allocated to AECM and OF support while decreasing direct payments in 2019. On the side of the demand for environmental commitments, it corresponds to a change in demand θ, such that the new budget in 2019 is $B_{19} + \tilde{B}_{19}$. Direct payments distributed to the sample in 2019 (DP_{19}) accounted for 6.7 billion €. The 2019 CAP budget already includes a 7.5% transfer to rural development measures (MAA, 2021). We first assume an additional transfer of 7.5% to reach 15%, which is the maximum rate allowed under current CAP regulations. The additional budget $\tilde{B}_{19} = \frac{DP_{19}}{1-0.075} * 0.075$ to be allocated is 541 million €. We keep the current budget ratio among the instruments: 53% to AECM ($\tilde{B}_{19}^{AECM}$=286 million €) and 47% to OF support ($\tilde{B}_{19}^{OFS}$= 255 million €). The budget to be allocated to sample farms is now $B_{19}^{AECM} + \tilde{B}_{19}^{AECM}$=514 million € and $B_{19}^{OFS} + \tilde{B}_{19}^{OFS}$=458 million €.

In practice, criteria Γ_i prevent some farms from participating in environmental contracts based on their location. Because we do not have enough information in the FADN to identify and control for non-eligibility in the case of AECM, our simulation approach is such that all farms of the sample become eligible to AECM under a new budget allocation scenario. Another (strong) necessary assumption is that the menu of measures M (technical requirements, area payment) is not affected by a budget transfer so that the estimated effects of the farm and farmer characteristics (a_{it},k_{it}) and the economic context (e_{it}) on the adoption decision and acceptable farm-level payments can be considered the same with a different budget allocation.

In the first stage, model estimates are used to predict farm probabilities and acceptable farm-level payments for enrolling in AECM (OF support respectively) in 2019 with a decrease of 7.5% of decoupled payments and coupled payments for suckler cows received. In the second stage, farms are ranked according to decreasing predicted probabilities of adopting AECM (OF support respectively). In the third stage, $B_{19}^{AECM} + \tilde{B}_{19}^{AECM}$ ($B_{19}^{OFS} + \tilde{B}_{19}^{OFS}$ respectively) is allocated to farms up to their predicted acceptable farm-level payment, starting with the farm with the highest probability to the lowest, until the budget is exhausted.

While keeping the budget ratio among instruments (53% to AECM and 47% to OF support), we also conduct additional simulations to identify the rate of budget transfer that would result in enough conversion OF support uptake to reach the target of 25% of organic area in France.

3. RESULTS

3.1 Estimated models of AECM and OF support uptake

To evaluate the model quality, we compare the observed participation and farm-level payments in 2016-2019 to the predicted probabilities of participation and acceptable farm-level payments (Table 3). The AECM adoption model tends to underestimate the probability of participating in AECM. On average, the estimated acceptable farm-level payments of AECM participants are in the range of their observed farm-level payments, although the standard deviation is lower, suggesting the model does not capture well extreme values. The OF support adoption model better captures the probability to participate, on average for the sample and in particular for maintenance OF support. The acceptable farm-level payment of participants is lower than observed farm-level payments on average, particularly for conversion OF support. Similarly to AECM, the model does not capture well the more extreme values. The difference between estimated and observed data for AECM can be partly explained by an omitted variable bias. In particular, missing data on whether the farm is located in an agri-environment-climate project area (exclusion criteria) may largely explain why the probability of AECM participation is underestimated. Similarly, it seems there are important factors explaining participation in conversion OF support that the model does not capture.

The marginal effects of our covariates of interest on the latent decision to participate and acceptable farm-level payment are summarized in Table 4. The marginal effects and the coefficients of all the model covariates are reported in Appendix A3. The estimated effects describe the equilibrium of supply and demand of environmental commitments during the 2016-2019 period. The effect of each factor is a net effect and captures both the

Table 3. Comparison between observed and estimated adoption behaviour[1].

	All sample	Participants
Agri-Environment-Climate Measures		
Observations	28,967	2,442
Observed participation (discrete)	0.09	1.00
Estimated participation probability (discrete)	0.05	0.49
Observed farm-level payment (€)	-	7,130 (6,692)
Estimated acceptable farm-level payment (€)	6,194 (5,728)	7,294 (3,757)
OF support		
Observations	28,967	1,657
Observed participation (discrete)	0.06	1.00
Estimated participation probability (discrete)	0.05	0.71
Observed farm-level payment (€)	-	8,834 (9,753)
Estimated acceptable farm-level payment (€)	10,360 (8,608)	8,236 (6,718)
Maintenance OF support		
Observations	28,967	1,364
Observed participation (discrete)	0.05	1.00
Estimated participation probability (discrete)	0.05	0.83
Observed farm-level payment (€)	-	8,143 (8,881)
Estimated acceptable farm-level payment (€)	6,850 (7,563)	7,792 (6,544)
Conversion OF support		
Observations	28,967	293
Observed participation (discrete)	0.01	1.00
Estimated participation probability (discrete)	0.00	0.03
Observed farm-level payment (€)	-	12,680 (12,963)
Estimated acceptable farm-level payment (€)	10,659 (8,625)	10,708 (7,124)

[1] All figures are weighted by the extrapolation coefficient of each observation. Standard deviation in parentheses.
Source: own elaboration.

effect of the demand $\theta(M,B,\Gamma)$ each farm faces (menu of measures and payments each farm is eligible to) and the effect of the characteristics Z_{it} of the supplying farms (opportunity costs, fixed costs, number of eligible hectares…). The effect of demand on the one hand, and supply, on the other hand, cannot be isolated. In particular, the effects of the covariates on AECM and OF support acceptable farm-level payments are difficult to interpret due to the high heterogeneity of contract requirements, payments per hectare and farm size. A positive effect on the acceptable farm-level payment reveals that ceteris paribus, the participation of a farmer is triggered either for a measure with a higher payment per hectare or for enrolling more hectares. The estimated marginal effects of the explanatory variables on the adoption decision can be more easily confronted to the literature.

The correlation estimates ρ of the selection and outcome equations are significant in both models. In particular, the acceptable farm-level payment for adopting AECM decreases with a higher probability of participation (significantly negative ρ), while the acceptable farm-level payment for adopting OF support increases with a higher probability of participation (significantly positive ρ). In other words, farms with a high likelihood of participating in AECM tend to participate for lower farm-level payments than other farms (participation is profitable for lower levels of farm-level payments), and farms with a high likelihood of participating in OF support tend to participate for higher farm-level payments than other farms (participation is profitable for higher levels of farm-level payments). This result supports our assumption that farmers behave differently regarding their adoption of AECM or OF support contracts, and confirms the relevance of estimating two different models. This difference may be explained by the fact that adopting an OF support contract often implies adopting organic practices on all the farmland and tends to be more costly to implement than AECM.

We observe that the probability of participating in OF support is not significantly affected by the amount of direct payments. Regarding AECM, while the effect of decoupled payments is also not significant, the probability of participation significantly increases with the amount of coupled payments for suckler cows received at the farm level (+0.1% per 1,000€). Decoupled direct payments have the opposite effect on OF support and AECM acceptable farm-level payments. Higher decoupled payments tend to increase OF support acceptable farm-level payments (+1,039€ per 100€/ha) and decrease AECM acceptable farm-level payments (-93€ per 100€/ha). Moreover, the model suggests the effect of coupled direct payments for suckler cows is significantly positive on AECM acceptable farm-level payments (+41€ per 1,000€) and not significant on OF support acceptable farm-level payments. We interpret the positive effect of coupled payments on AECM adoption probability as resulting from the large set of AECM contracts designed in France for grazing livestock farming systems, more likely to have suckler cows on the farm (MAA, 2020). In the literature, the effect of coupled support on AECM adoption depends on the study (Allaire et al., 2011; Pufahl and Weiss, 2009). Our results confirm those of Pufahl and Weiss (2009) in Germany, but we can expect the effect to vary according to the Member

Table 4. Generalised Tobit models estimation: marginal effects at the sample mean.

	AECM		OF support	
	Participation decision (D_i^*)	Acceptable farm-level payment (P_i^*) in 1,000€	Participation decision (D_i^*)	Acceptable farm-level payment (P_i^*) in 1,000€
Decoupled payments (100€/ha)	0.000 (0.000)	-0.093* (0.020)	-0.000 (0.000)	1.039*** (0.220)
Coupled payment for suckler cows (1,000€)	0.001*** (0.001)	0.041+ (0.009)	0.000 (0.000)	0.053 (0.011)
ρ	-0.034*** (0.005)	-	0.133*** (0.011)	-
σ	-	5.581*** (0.013)	-	6.978*** (0.020)
Number of observations	28,967	2,442	28,967	1,657
Log-likelihood	-504,317		-318,531	
AIC	1,008,948		637,376	
Schwarz criterion	1,010,826		639,254	
Pseudo-R2 (McFadden)	0.241		0.378	

Significance levels: *** p-value <0.001, ** p-value <0.01, * p-value<0.05, + p-value<0.1. Standard errors in parentheses. AWU: annual work unit. LU: livestock unit.
Source: own elaboration.

States and the set of AECM contracts that were designed according to local priorities.

The effects of the other covariates controlling for the economic context (fuel price, land lease), and the farm and farmer characteristics are also significant, in particular on participation probabilities. Most findings confirm the literature. For instance, the negative effects of age, the cost of land lease and depreciation on AECM adoption probability are coherent with (Andreoli et al., 2022; Damianos and Giannakopoulos, 2002; Defrancesco et al., 2018; Mack et al., 2020; Pavlis et al., 2016; Pufahl and Weiss, 2009; Uthes and Matzdorf, 2013; Vanslembrouck et al., 2002; Zimmermann and Britz, 2016). The positive effects of the economic size, UAA, shares of grasslands and rented area, location in a Natura2000 area, education and past participation on AECM adoption probability also confirm previous findings (Allaire et al., 2011; Andreoli et al., 2022; Chatzimichael et al., 2014; Damianos and Giannakopoulos, 2002; Defrancesco et al., 2018; Giovanopoulou et al., 2011; Mack et al., 2020; Pavlis et al., 2016; Pufahl and Weiss, 2009; Uthes and Matzdorf, 2013; Zimmermann and Britz, 2016). Regarding OF support adoption, the negative effect of age and the positive effects of general education and being located in a less favoured area are coherent with other studies (Kallas et al., 2010; Koesling et al., 2008; Läpple and Rensburg, 2011). Similarly, to the literature (Andreoli et al., 2022; Koesling et al., 2008; Mack et al., 2020; McGurk et al., 2020), we observe that the farm specialisation and region are significant factors of adoption for both OF support and AECM. As expected, we find that a higher fuel price increases the probability of adopting an environmental contract. Ceteris paribus, we also see that participation in AECM (OF support respectively), significantly decreases if the farm participated in OF support (AECM respectively) the year before. We also find some surprising results. We find a negative effect of location in a less favoured area on the probability of participating in AECM, which differs from previous results (Allaire et al., 2011; Andreoli et al., 2022; Mack et al., 2020; Zimmermann and Britz, 2016). Other unexpected results are the negative effect of agricultural education and the positive effect of the grazing livestock load on the probability of participating in OF support (Koesling et al., 2008; Läpple and Rensburg, 2011).

A finding of this study is that the adoption behaviour of AECM and OF support differs. In addition to differences regarding the effects of direct payments, we find opposite effects of some covariates on the probabilities of participation in AECM and OF support (agricultural education, location in a Natura2000 or less favoured area, economic size, depreciation, cost of land lease and share of grasslands) on the probabilities of participation in AECM and OF support. On the supply side (farmers), it can be explained by the fact that the implications of both types of contracts are different. One is the prospect of a long-term commitment to OF, while the other is a mid-term commitment (5 years). On the demand side (public authorities), the defined eligibility rules result in some contract types and measures not being open to all types of farms, driving or constraining farmers' behaviour.

3.2 Results of the simulations

The predicted impact on farmers' uptake of environmental contracts of a transfer of an additional 7.5%

(reaching the maximum transfer rate of 15% between the two CAP pillars under current regulations) of direct payments to AECM and OF support in 2019 in France is presented in Table 5. Participation in AECM increases from 11% to 23%, and in OF support from 7% to 15%. While the AECM budget more than doubles (+126%), participation and the UAA of participants increase proportionally less (+115% and +111% respectively). It suggests decreasing returns of a budget increase and that AECM participants with the new budget allocation tend to have smaller farms. Regarding OF support, participation (+123%) increases proportionally to the budget increase (+125%), but the UAA of participants increases proportionally more (+142% respectively). Contrary to AECM, predicted OF support beneficiaries under the new budget allocation tend to have larger farms. In addition, after the budget transfer, the share of the sample participating in both OF support and AECM increased from 0.8% to 7.5%. The share of AECM participants with an OF support contract increases from 7.7% to 32.1%, while the share of OF support participants with an AECM increases from 12.1% to 29.9%.

Two combined incentives explain this result. First, there is a direct effect of more budget dedicated to financing environmental commitments. More acceptable farm-level payments can be covered and participation becomes profitable for a larger share of farms. This additional budget is taken from 85% of observations receiving direct payments (99.0% of the UAA) and is redistributed to 27.5% of observations (33.0% of the UAA). 19.9% are new adopters of environmental contracts and 7.5% are observed participants in 2019 to which the simulation allocates an additional payment (adoption of additional measures or enrolment of additional hectares). Second, there is an indirect effect of the decrease of direct payments on acceptable farm-level payments. The average change of acceptable farm-level payment per farm is -197€ for OF support and +8€ for AECM. The "savings" observed for OF support contracts contribute to financing the participation of even more farms.

We identify a differentiated impact of the budget transfer according to the type of farm (Table 6). The farms losing the most income from lower direct payments are specialised in mixed cattle (-3,115 €/farm on average in otexe 47) and in mixed farming with field crops and grazing livestock (-3,015€/farm on average in otexe 83). The less affected farms are specialised in horticulture (-56€/farm on average in otexe 29) and quality wine (-205€/farm on average in otexe 37). On the one hand, the reorientation of the budget particularly incentivises farms specialised in grazing livestock to contract AECM (otexe 45, 46, 47, 48, 73 and 83). This result seems driven by the effect of lower coupled payments for suckler cows which tends to decrease the AECM acceptable farm-level payment. Farms specialised in grazing livestock typically receive more coupled payments for suckler cows than other farm types and decide to participate in AECM for lower farm-level payments after the budget transfer. In addition, for farms with grazing livestock, the effect of the amount of coupled payments for suckler cows on the AECM acceptable farm-level payment compensates for the opposite effect of decoupled payments. Therefore, contrary to other farm specialisation, AECM acceptable farm-level payments tend to decrease or remain stable for farms specialised in beef (-23€/farm on average in otexe 46), mixed cattle (-8€/farm on average in otexe 47) or mixed farming with field crops and grazing livestock (+0.2€/farm on average in otexe 83). On the other hand, the reorientation of the budget particularly incentivises farms specialised in cereal and field crops, permanent crops, dairy, pigs and poultry or mixed farming with field crops and grazing livestock to contract OF

Table 5. Predicted impact of an additional decrease of 7.5% in direct payments in 2019 (N=7,194)[1].

	Baseline			With a budget transfer		
	AECM	OF support	AECM or OF support	AECM	OF support	AECM or OF support
Budget (1,000€)	227,862	203,267	431,130	514,752	457,679	972,431
Share of farms (%)	10.8	6.9	16.8	23.2	15.3	33.0
Total UAA of participants (ha)	3,808,678	1,657,456	5,148,400	8,043,437	4,015,962	10,423,722
Share of total UAA (%)	14.5	6.3	19.6	30.7	15.3	39.7
Payment of participants (€) (D=1)	7,279 (6,768)	10,238 (12,032)	8,843 (9,758)	7,661 (3,777)	10,348 (8,514)	10,186 (7,900)
Acceptable farm-level payment (€)	6,473 (5,692)	10,624 (7,918)	-	6,481 (8,689)	10,427 (7,884)	-

[1] All figures are weighted by the extrapolation coefficient of each observation.
Standard deviation in parentheses.
Source: own elaboration.

Table 6. Allocation of environmental incentives (%) among the types of farms with and without a transfer of an additional 7.5% of the direct payments budget in 2019 (N=7,194)[1].

Technical orientation	AECM - baseline	AECM – budget transfer	OF support - baseline	OF support - budget transfer
Cereals, oleaginous, protein crops	16.69	9.31	16.46	18.00
Other field crops	3.96	2.22	6.35	4.06
Vegetable gardening	0.74	0.32	4.93	4.36
Horticulture	0.00	0.11	1.76	1.93
Wine with quality label	3.75	2.99	14.79	11.77
Other wine	0.75	0.38	0.11	0.49
Other permanent crops	1.16	0.84	6.35	9.05
Dairy farming	17.67	21.14	18.08	19.23
Beef farming	24.87	25.86	7.34	7.67
Mixed cattle farming	4.79	6.81	1.39	0.95
Sheep and goat farming	6.25	8.90	5.57	3.37
Pigs and poultry farming	2.60	2.14	2.48	4.65
Mixed crops farming	0.78	0.18	2.79	2.76
Mixed livestock dominated by grazing livestock	0.18	0.73	1.92	2.03
Mixed livestock dominated by granivores	1.09	0.68	1.31	1.22
Mixed farming: field crops and grazing livestock	10.37	13.58	3.66	4.81
Mixed farming: other combination of crops and livestock	4.31	3.79	4.71	3.66

[1] All figures are weighted by the extrapolation coefficient of each observation.
Source: own elaboration.

support (otexe 15, 38, 39, 45, 50 and 83). Those results are driven by the decrease in acceptable farm-level payments associated with lower decoupled payments (on average -227€/farm in otexe 15, -235€/farm in otexe 45 and -242€/farm in otexe 83). On average, those farm types decide to participate in OF support for lower farm-level payments after the budget transfer.

The outputs of simulations in terms of predicted shares of farms and share of UAA participating in environmental contracts under different budget transfer scenarios from the first pillar to AECM and OF support (in addition to the 7.5% already transferred from direct payments to the measures of the second pillar since 2017) are presented in Figure 1 and Figure 2[1]. The share of UAA is calculated from the sum of the UAAs of the farms for which we predict participation, divided by the total UAA. We conducted several simulations up to a maximum of 30% of transfer between the two pillars, as the higher the additional transfer compared to the observed situation, the less realistic our prediction becomes. We observe that the participation rate and UAA under environmental contracts increase linearly with the budget transfer rate. In 2019, almost 9% of the UAA was organic (including the total UAA of all farms certified organic and in conversion, whether they receive OF support or not). In the scenario of a 15% transfer between the two pillars (7.5%+7.5%), the uptake of conversion OF support is such that the organic UAA doubles. To reach 25% of organic UAA (Green Deal objective by 2030), our model suggests an additional transfer

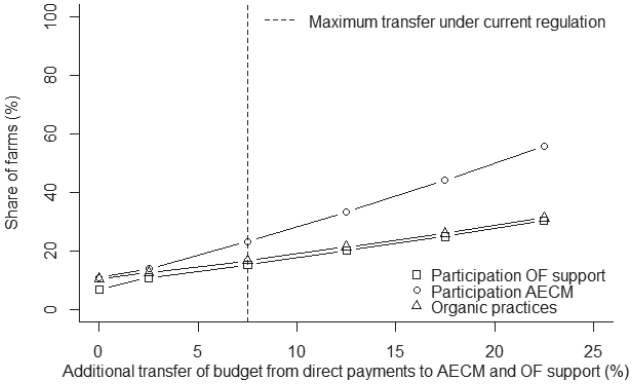

Figure 1. Participation in environmental contracts and implementation of organic practices under several scenarios of an additional budget transfer from direct payments to AECM and OF support in 2019 (N=7,194). All figures are weighted by the extrapolation coefficient of each observation. AECM: agri-environment-climate measures. OF: organic farming. Budget allocation assumption: 53% AECM/47% OF support. Source: own elaboration.

[1] Note that we maintain the budget allocation ratio of 53%/47% between AECM and OF support in all our scenarios.

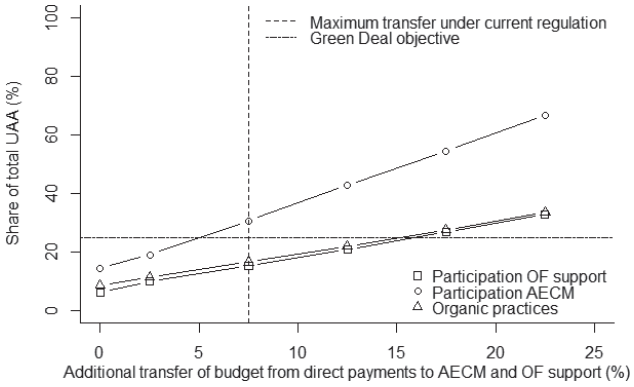

Figure 2. UAA of the farms participating in environmental contracts and implementing organic practices under several scenarios of an additional budget transfer from direct payments to AECM and OF support in 2019 (N=7,194). All figures are weighted by the extrapolation coefficient of each observation. AECM: agri-environment-climate measures. OF: organic farming. UAA: utilised agricultural area. Budget allocation assumption: 53% AECM/47% OF support. Source: own elaboration.

rate of 15.5% (to reach 23% of transfer between the two pillars). If we restrict eligibility to OF support to non-certified farms (if we allocate the additional OF support budget to conventional farms or farms converting to OF, as in some French regions since 2017 and now at the national level in the current CAP 2023-2027), the additional transfer rate to meet the Green Deal objective is 10.5% (to reach 18% of transfer between the two pillars). However, this finding needs to be carefully interpreted, as it results from estimations using empirical data for which such eligibility restriction did not exist in a majority of French regions. Removing maintenance OF support is a strong policy change for which our empirical model would likely no longer fit to represent the uptake behaviour of farms.

4. DISCUSSION ON THE LIMITS OF THE MODELLING APPROACH

This study proposes a methodological approach to model farmers' behaviour at a national scale regarding the uptake of environmental commitments within the framework of the CAP 2014-2020 in France, applied using FADN data available in all EU countries. We used it to evaluate ex-ante the impact of CAP budget allocation changes on the adoption of environmental contracts while capturing the effect of income support instruments on this adoption behaviour. The results can be analysed at the farm level, highlighting a differentiated impact according to farm specialisation.

Nevertheless, the predicted results need to be interpreted with care, as they depend on the quality of the adoption model estimated. In particular, our model tends to underestimate the probabilities of adoption compared to observed data, in particular for AECM and conversion OF support.

We identify four main limits to the modelling approach we propose. First, there is insufficient information in the FADN to precisely capture AECM eligibility and the characteristics of the measures adopted by farmers. In particular, not controlling for the diversity of the payments per hectare and surfaces enrolled for the different AECM and OF support contracts remains an important limitation of this work, as they represent sources of heterogeneity across farms that we do not capture. To improve this aspect, one possibility is to merge the FADN sample with the dataset on participants to rural development measures collected each year for the annual implementation report (RAMO) and collect some of the missing information (surfaces under contract, measure adopted by each farm, municipalities eligible to AECM). Second, beyond measure characteristics and contract eligibility, there are additional unobserved factors explaining farmers' adoption that our model does not capture. AECM and OF support payments are typically defined as compensation payments based on income foregone and often do not represent significant economic incentives. As a result, the (unknown) intrinsic motivation due to personal concerns towards the environment is likely to play a major role in explaining the adoption behaviour of a farmer. Moreover, in the case of OF support adoption, other existing policies to support the organic market such as the tax abatement in France, as well as the demand for organic products expressed by consumers, also drive farmers' decisions. Neighbourhood effects may also determine farmers choice to adopt environment-friendly practices. To correct the matrix of covariances for spatial dependence of observations and allow for spatial correlation of the error terms, applying non-parametric methods based on the definition of an economic distance metric among agents could be envisaged with the relevant data (Schlenker and Roberts, 2009; Conley, 1999). A third important limit to the study is that the reliability of the predictions decreases for higher rates of reduction of direct payments. A transfer of budget from the first pillar to AECM and OF support is a significant policy change that would likely have repercussions on agricultural input and output markets, and in particular, affect the price of organic and conventional products. Therefore, our simulation approach using *marginal* effects to model a change in farmers' behaviour becomes less real-

istic the larger the budget transfer we simulate. Finally, our model could also be subject to a simultaneity bias for some of the covariates, as participation in AECM or OF support may affect some farm characteristics such as the standard gross production.

5. CONCLUDING REMARKS

AECM and OF support are currently the most ambitious environmental contracts in the CAP. We evaluated the potential to upscale their adoption without increasing the CAP budget, by transferring part of the budget for direct payments with little environmental conditionality to fund additional environmental contracts in France in 2019. Our findings suggest this mechanism successfully increases participation by combining two incentives. First, we identify a direct effect of more public money dedicated to financing environmental commitments. Second, we identify an indirect effect on farmers' behaviour of receiving lower direct payments, which tends to decrease the acceptable farm-level payment triggering their decision to participate in OF support, making even more money available to finance more environmental commitments.

Our empirical findings support the relevance of decreasing payments with little environmental conditionality and increasing payments targeted towards the delivery of environmental public goods in the CAP. Previous evaluation of the reorientation of 15% of direct payments towards rural development measures in the EU28 and in Germany with the CAPRI partial equilibrium model identified marginal impacts on environmental indicators (Schroeder, 2021; Schroeder et al., 2015). Another study in Greece suggests that 50% transfer would lead to an extensification of farming practices and improve water quality and biodiversity (Giannakis et al., 2014). While a transfer from direct payments to environmental incentives with the current regulation (maximum 15%) is unlikely to be sufficient to achieve the Farm to Fork target of 25% of organic land, our results suggest it can significantly contribute to it. The French government decided to limit eligibility to OF support to non-certified farms in the 2023-2027 CAP programming period. Our predictions show this targeting would theoretically encourage the conversion of new land to organic and facilitate reaching the Green Deal objective. However, removing maintenance OF support can hinder the Green Deal objective in the long term if keeping organic practices is not profitable through the market. Finally, other levers can be applied such as improving environmental contract design to increase their attractiveness and environmental effectiveness, as well as supporting the development of the organic market. The new eco-schemes financed with 25% of the direct payments envelope in the CAP for the 2023-2027 programming period for which all EU farmers are eligible, could also contribute to triggering more voluntary adoption. However, a study analysing the French eco-schemes showed that almost all farms would fulfil the technical requirements without changing their current practices, casting doubt on the possibilities to reach significant environmental additionality with this new policy instrument (Lassalas et al., 2023).

The limitations of the study highlight the need for complementary research to improve the modelling of environmental contract adoption. In particular, the intrinsic motivation and values of farmers, but also locational factors play an important role in the adoption of AECM and OF support. They are not sufficiently documented in the FADN. While the upcoming transformation of the FADN into the Farm Sustainability Data Network (FSDN) may contribute to facilitate access to a larger set of social, economic, and environmental factors, currently, combining different secondary farm datasets, collecting more data through farmers surveys, and/or using spatial data on pedoclimatic and meteorological conditions would be necessary to better understand farmers adoption behaviour.

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APPENDICES

Appendix A1. Farm Accountancy Data Network sample coverage of farms with organic practices

Table A1.1. Sample coverage of farms with organic practices in 2019.

	In conversion to organic farming	Certified organic	Certified or in conversion to organic farming
France			
Number of farms	n.a	n.a	47,196
Share of farms (%)	n.a	n.a	10.4
UAA (ha)	565,574	1,675,711	2,241,345
Share of UAA (%)	1.9	5.8	8.3
Sample[1]			
Number of farms	5,905	24,805	30,710
Share of farms (%)	2.0	8.6	10.6
UAA (ha)	545,601	1,705,243	2,250,844
Share of UAA (%)	2.1	6.5	8.6

[1] All figures are weighted by the extrapolation coefficient of each observation.
Sources: 2019 French FADN data, 2019 Agence Bio data.

Appendix A2. Descriptive statistics of the Farm Accountancy Data Network sample

Table A2.1. Education level of the farms of the sample (N=28,967)[1].

Level of education	%
Agricultural	
None or training of less than 120 hours	6.85
Primary agricultural education	12.57
Secondary agricultural education (short)	41.27
Secondary agricultural education (long)	27.57
Agricultural higher education (short)	10.53
Agricultural higher education (long)	1.20
General	
None	7.14
Primary school certificate	11.82
Secondary education (short)	50.52
Secondary education (long)	26.30
Non-agricultural higher education	4.22

[1] All figures are weighted by the extrapolation coefficient of each observation.
Source: 2016-2019 French FADN data.

Table A2.2. Regions of the farms of the sample (N=28,967)[1].

Region	%
Ile de France	1.42
Champagne-Ardenne	6.23
Picardie	3.52
Haute-Normandie	2.20
Centre	5.97
Basse-Normandie	3.90
Bourgogne	4.99
Nord Pas de Calais	3.40
Lorraine	2.54
Alsace	2.25
Franche-Comté	1.98
Pays de la Loire	8.16
Bretagne	8.31
Poitou-Charentes	5.69
Aquitaine	7.62
Midi-Pyrénées	8.40
Limousin	2.55
Rhône-Alpes	6.66
Auvergne	4.59
Languedoc Roussillon	5.25
Provence-Alpes-Côte d'Azur	3.84
Corse	0.54

[1] All figures are weighted by the extrapolation coefficient of each observation.
Source: 2016-2019 French FADN data.

Table A2.3. Technical orientations of the farms of the sample (N=28,967)[1].

Technical orientation	OTEX number	%
Cereals, oleaginous, protein crops	15	18.25
Other field crops	16	6.70
Vegetable gardening	28	1.73
Horticulture	29	2.07
Wine with quality label	37	13.81
Other wine	38	1.50
Other permanent crops	39	2.46
Dairy farming	45	14.97
Beef farming	46	10.39
Mixed cattle farming	47	3.53
Sheep and goat farming	48	5.47
Pigs and poultry farming	50	5.48
Mixed crops farming	61	1.64
Mixed livestock dominated by grazing livestock	73	1.20
Mixed livestock dominated by granivores	74	1.35
Mixed farming: field crops and grazing livestock	83	7.36
Mixed farming: other combination of crops and livestock	84	2.10

[1] All figures are weighted by the extrapolation coefficient of each observation.
Source: 2016-2019 French FADN data

Appendix A3. Coefficients and marginal effects of the generalised Tobit models

Table A3.1. Estimates of the generalised Tobit models for the uptake of agri-environment-climate measures and organic farming support.

	AECM		OF support	
	Participation decision (D_i*)	Acceptable farm-level payment (P_i*) in 1,000€	Participation decision (D_i*)	Acceptable farm-level payment (P_i*) in 1,000€
Intercept	-1.149*** (0.047)	0.635 (0.456)	-3.585*** (0.071)	-10.008*** (0.740)
Decoupled payments (100€/ha)	0.001 (0.001)	-0.119* (0.056)	-0.001 (0.001)	1.242*** (0.132)
Coupled payment for suckler cows (1,000€)	0.014*** (0.004)	0.052+ (0.029)	0.006 (0.007)	0.063 (0.055)
Fuel price (€/l)	0.453*** (0.034)	-0.133 (0.288)	0.168*** (0.048)	0.137 (0.403)
Land lease (100€/ha)	-0.002*** (0.000)	-0.009 (0.011)	0.007*** (0.001)	0.046+ (0.027)
Standard gross production (100,000€)	0.053*** (0.007)	-0.232*** (0.061)	-0.042*** (0.007)	-0.269*** (0.067)
Labour (AWU/ha)	-0.003* (0.001)	0.008 (0.245)	-0.472*** (0.026)	0.844 (0.848)
Utilised agricultural area (100ha)	0.277*** (0.024)	-0.402* (0.200)	0.455*** (0.039)	10.757*** (0.501)
Depreciation (10,000€/ha)	-0.020*** (0.004)	0.029 (0.099)	0.122* (0.054)	-9.692*** (1.167)
Share of rented land	0.063* (0.032)	1.682*** (0.293)	0.143*** (0.038)	-0.697* (0.340)
Less favoured area	-0.031*** (0.007)	-0.781*** (0.057)	0.129*** (0.011)	-0.085 (0.090)
Cereals, oleaginous, protein crops, other field crops	-0.507*** (0.009)	0.458*** (0.082)	0.014 (0.015)	1.084*** (0.137)
Vegetable gardening, horticulture	-1.208*** (0.026)	-0.019 (0.339)	0.136*** (0.023)	-0.054 (0.188)
Wine with quality label, other wine	-0.468*** (0.013)	-0.139 (0.141)	-0.102*** (0.018)	0.713*** (0.159)
Other permanent crops	-0.529*** (0.021)	0.911*** (0.215)	0.741*** (0.020)	2.832*** (0.167)
Dairy farming	-0.100*** (0.009)	1.941*** (0.078)	0.360*** (0.016)	2.879*** (0.135)
Beef farming	0.041*** (0.010)	0.711*** (0.076)	0.242*** (0.018)	-1.638*** (0.149)
Mixed cattle farming	0.143*** (0.012)	1.347*** (0.092)	0.195*** (0.025)	0.162+ (0.225)
Sheep and goat farming	0.147*** (0.011)	0.556*** (0.089)	0.034* (0.018)	-0.489* (0.147)
Pigs and poultry farming, mixed livestock dominated by granivores	-0.329*** (0.013)	-0.331** (0.117)	0.193*** (0.019)	0.299** (0.170)
Mixed crops farming	-0.482*** (0.022)	1.210*** (0.251)	0.326*** (0.024)	2.825*** (0.188)
Mixed livestock dominated by grazing livestock	-0.303*** (0.021)	1.895*** (0.210)	0.518*** (0.029)	0.073 (0.234)
Mixed farming: field crops and grazing livestock, other combination of crops and livestock	Baseline			
Age (years)	-0.005*** (0.000)	0.061*** (0.002)	-0.017*** (0.000)	0.017* (0.003)
No general education	-0.382*** (0.013)	-0.825*** (0.107)	-0.545*** (0.018)	-0.368*** (0.165)
Primary school certificate	-0.473*** (0.013)	-1.344*** (0.113)	-0.543*** (0.019)	1.324*** (0.185)
Secondary education (short)	-0.319*** (0.010)	-1.828*** (0.089)	-0.309*** (0.014)	0.229+ (0.130)
Secondary education (long)	-0.277*** (0.010)	-1.584*** (0.087)	-0.237*** (0.014)	-0.205 (0.131)
Non-agricultural higher education	Baseline			
No agricultural education or training ≤120 h	-0.199*** (0.019)	-3.090*** (0.159)	0.072** (0.026)	4.018*** (0.236)
Primary agricultural education	-0.208*** (0.019)	-3.767*** (0.146)	0.043+ (0.025)	3.903*** (0.228)
Secondary agricultural education (short)	-0.234*** (0.018)	-2.845*** (0.135)	0.243*** (0.024)	2.409*** (0.204)
Secondary agricultural education (long)	-0.230*** (0.017)	-2.458*** (0.133)	-0.004 (0.023)	3.385*** (0.207)
Agricultural higher education (short)	-0.061*** (0.018)	-2.186*** (0.135)	0.105*** (0.024)	3.707*** (0.209)
Agricultural higher education (long)	Baseline			
Share of permanent grasslands	0.352*** (0.038)	-3.235*** (0.322)	-0.313*** (0.054)	-2.708*** (0.454)
Density of grazing livestock (LU/ha)	0.135*** (0.014)	-0.503* (0.243)	0.396*** (0.034)	0.308 (0.452)
Natura	0.414*** (0.009)	0.425*** (0.064)	-0.012+ (0.016)	2.443*** (0.138)
Organic certification	0.303*** (0.032)	-0.872*** (0.218)	1.208*** (0.024)	2.672*** (0.185)
Ile de France	0.504*** (0.032)	3.117*** (0.328)	2.421*** (0.055)	15.726*** (0.580)
Champagne-Ardenne	0.053+ (0.030)	-0.743** (0.280)	1.605*** (0.058)	7.043*** (0.601)
Picardie	0.410*** (0.030)	1.407*** (0.287)	2.326*** (0.054)	7.055*** (0.576)

(Continued)

Table A3.1. (Continued).

	AECM		OF support	
	Participation decision (D_i*)	Acceptable farm-level payment (P_i*) in 1,000€	Participation decision (D_i*)	Acceptable farm-level payment (P_i*) in 1,000€
Haute-Normandie	-0.127*** (0.031)	0.859** (0.301)	2.146*** (0.056)	4.871*** (0.582)
Centre	-0.061* (0.029)	3.680*** (0.284)	2.151*** (0.052)	8.162*** (0.560)
Basse-Normandie	-0.518*** (0.029)	2.688*** (0.275)	2.045*** (0.052)	4.771*** (0.551)
Bourgogne	-0.278*** (0.029)	0.501+ (0.277)	2.700*** (0.051)	7.443*** (0.548)
Nord Pas de Calais	0.203*** (0.030)	-0.874** (0.300)	2.212*** (0.055)	6.374*** (0.587)
Lorraine	0.018 (0.030)	1.760*** (0.300)	2.697*** (0.053)	13.271*** (0.559)
Alsace	-0.038 (0.033)	-0.703* (0.290)	2.524*** (0.054)	8.225*** (0.573)
Franche-Comté	-0.394*** (0.031)	-3.171*** (0.285)	2.284*** (0.054)	2.790*** (0.564)
Pays de la Loire	0.115*** (0.029)	4.436*** (0.274)	2.609*** (0.051)	5.287*** (0.546)
Bretagne	0.642*** (0.029)	4.699*** (0.278)	1.862*** (0.052)	4.997*** (0.559)
Poitou-Charentes	0.417*** (0.028)	2.938*** (0.271)	2.350*** (0.052)	8.691*** (0.554)
Aquitaine	-0.180*** (0.028)	-1.370*** (0.284)	2.490*** (0.050)	6.601*** (0.543)
Midi-Pyrénées	-0.450*** (0.028)	-2.529*** (0.282)	2.332*** (0.049)	7.353*** (0.536)
Limousin	-0.336*** (0.030)	-1.118*** (0.291)	2.448*** (0.054)	5.751*** (0.567)
Rhône-Alpes	0.066* (0.028)	-1.397*** (0.272)	2.553*** (0.050)	5.932*** (0.538)
Auvergne	-0.278*** (0.029)	-3.526*** (0.279)	2.410*** (0.052)	5.715*** (0.555)
Languedoc Roussillon	0.149*** (0.028)	0.914** (0.286)	2.176*** (0.050)	5.819*** (0.538)
Provence-Alpes-Côte d'Azur	0.458*** (0.029)	2.017*** (0.278)	1.756*** (0.051)	3.481*** (0.550)
Corse	Baseline			
Observed participation in AECM in 2015	2.512*** (0.007)	-	-	-
Observed participation in OF support at t-1	-0.280*** (0.020)	0.017 (0.165)	-	-
Observed participation in OF support in 2015	-	-	1.407*** (0.010)	-
Observed participation in AECM at t-1	-	-	-0.236*** (0.023)	0.684*** (0.207)
2016	-0.363*** (0.009)	-0.603*** (0.077)	-0.241*** (0.013)	-0.168 (0.116)
2017	-0.228*** (0.008)	-0.593*** (0.064)	-0.325*** (0.011)	-0.582*** (0.098)
2018	-0.171*** (0.007)	-0.164** (0.057)	-0.389*** (0.010)	-0.512*** (0.087)
2019	Baseline			
ρ	-0.034*** (0.005)	-	0.133*** (0.011)	-
σ	-	5.581*** (0.013)	-	6.978*** (0.020)
Number of observations	28,967	2,442	28,967	1,657
Log-likelihood	-504,317		-318,531	
AIC	1,008,948		637,376	
Schwarz criterion	1,010,826		639,254	
Pseudo-R2 (McFadden)	0.241		0.378	

Significance levels: *** p-value <0.001, ** p-value <0.01, * p-value<0.05, + p-value<0.1. Standard errors in parentheses.
AWU: annual work unit. LU: livestock unit.
Source: own elaboration.

Table A3.2. Generalised Tobit models estimation: marginal effects at the sample mean.

	AECM		OF support	
	Participation decision (D_i*)	Acceptable farm-level payment (P_i*) in 1,000€	Participation decision (D_i*)	Acceptable farm-level payment (P_i*) in 1,000€
Decoupled payments (100€/ha)	0.000 (0.000)	-0.093* (0.020)	-0.000 (0.000)	1.039*** (0.220)
Coupled payment for suckler cows (1,000€)	0.001*** (0.001)	0.041+ (0.009)	0.000 (0.000)	0.053 (0.011)
Fuel price (€/l)	0.041*** (0.039)	-0.105 (0.022)	0.007*** (0.013)	0.114 (0.024)
Land lease (100€/ha)	-0.000*** (0.000)	-0.007 (0.001)	0.000*** (0.001)	0.039+ (0.008)
Standard gross production (100,000€)	0.005*** (0.005)	-0.182*** (0.039)	-0.002*** (0.003)	-0.225*** (0.048)
Labour (AWU/ha)	-0.000* (0.000)	0.006 (0.001)	-0.019*** (0.037)	0.706 (0.149)
Utilised agricultural area (100ha)	0.025*** (0.024)	-0.316* (0.068)	0.018*** (0.035)	8.997*** (1.902)
Depreciation (10,000€/ha)	-0.002*** (0.002)	0.023 (0.005)	0.005* (0.009)	-8.106*** (1.713)
Share of rented land	0.006* (0.005)	1.322*** (0.283)	0.006*** (0.011)	-0.583* (0.123)
Less favoured area	-0.003*** (0.003)	-0.614*** (0.131)	0.005*** (0.010)	-0.071 (0.015)
Cereals, oleaginous, protein crops, other field crops	-0.046*** (0.044)	0.360*** (0.077)	0.001 (0.001)	0.906*** (0.192)
Vegetable gardening, horticulture	-0.109*** (0.105)	-0.015 (0.003)	0.006*** (0.010)	-0.045 (0.010)
Wine with quality label, other wine	-0.042*** (0.040)	-0.110 (0.023)	-0.004*** (0.008)	0.596*** (0.126)
Other permanent crops	-0.048*** (0.046)	0.716*** (0.153)	0.030*** (0.057)	2.369*** (0.501)
Dairy farming	-0.009*** (0.009)	1.526*** (0.327)	0.015*** (0.028)	2.408*** (0.509)
Beef farming	0.004*** (0.004)	0.559*** (0.120)	0.010*** (0.019)	-1.370*** (0.290)
Mixed cattle farming	0.013*** (0.012)	1.059*** (0.227)	0.008*** (0.015)	0.135+ (0.029)
Sheep and goat farming	0.013*** (0.013)	0.437*** (0.094)	0.001* (0.003)	-0.409* (0.086)
Pigs and poultry farming, mixed livestock dominated by granivores	-0.030*** (0.028)	-0.260** (0.056)	0.008*** (0.015)	0.250** (0.053)
Mixed crops farming	-0.043*** (0.042)	0.951*** (0.204)	0.013*** (0.025)	2.363*** (0.499)
Mixed livestock dominated by grazing livestock	-0.027*** (0.026)	1.489*** (0.319)	0.021*** (0.040)	0.061 (0.013)
Mixed farming: field crops and grazing livestock, other combination of crops and livestock	Baseline			
Age (years)	-0.000*** (0.000)	0.048*** (0.010)	-0.001*** (0.001)	0.014*** (0.003)
No general education	-0.034*** (0.033)	-0.649*** (0.139)	-0.022*** (0.042)	-0.308*** (0.065)
Primary school certificate	-0.043*** (0.041)	-1.057*** (0.226)	-0.022*** (0.042)	1.107*** (0.234)
Secondary education (short)	-0.029*** (0.028)	-1.437*** (0.308)	-0.013*** (0.024)	0.191+ (0.040)
Secondary education (long)	-0.025*** (0.024)	-1.245*** (0.267)	-0.010*** (0.018)	-0.171 (0.036)
Non-agricultural higher education	Baseline			
No agricultural education or training ≤120 h	-0.018*** (0.017)	-2.429*** (0.520)	0.003** (0.006)	3.361*** (0.710)
Primary agricultural education	-0.019*** (0.018)	-2.961*** (0.634)	0.002+ (0.003)	3.264*** (0.690)
Secondary agricultural education (short)	-0.021*** (0.020)	-2.237*** (0.479)	0.010*** (0.019)	2.015*** (0.426)
Secondary agricultural education (long)	-0.018*** (0.018)	-1.932*** (0.414)	-0.000 (0.000)	2.831*** (0.598)
Agricultural higher education (short)	-0.005*** (0.005)	-1.718*** (0.368)	0.004*** (0.008)	3.101*** (0.655)
Agricultural higher education (long)	Baseline			
Share of permanent grasslands	0.032*** (0.030)	-2.543*** (0.544)	-0.013*** (0.024)	-2.265*** (0.479)
Density of grazing livestock (LU/ha)	0.012*** (0.012)	-0.396* (0.085)	0.016*** (0.031)	0.258 (0.054)
Natura	0.037*** (0.036)	0.334*** (0.071)	-0.000+ (0.001)	-2.043*** (0.432)
Organic certification	0.027*** (0.026)	-0.685*** (0.147)	0.049*** (0.093)	2.235*** (0.472)
Ile de France	0.045*** (0.044)	2.450*** (0.525)	0.098*** (0.187)	13.153*** (2.780)
Champagne-Ardenne	0.005+ (0.005)	-0.584** (0.125)	0.065*** (0.124)	5.890*** (1.245)
Picardie	0.037*** (0.035)	1.106*** (0.237)	0.094*** (0.180)	5.900*** (1.247)
Haute-Normandie	-0.011*** (0.011)	0.676** (0.145)	0.087*** (0.166)	4.074*** (0.861)
Centre	-0.005* (0.005)	2.893*** (0.619)	0.087*** (0.166)	6.827*** (1.443)
Basse-Normandie	-0.047*** (0.045)	2.113*** (0.452)	0.083*** (0.158)	3.990*** (0.844)
Bourgogne	-0.025*** (0.024)	0.394+ (0.084)	0.110*** (0.209)	6.225*** (1.316)

(Continued)

Table A3.2. (Continued).

	AECM		OF support	
	Participation decision (D_i*)	Acceptable farm-level payment (P_i*) in 1,000€	Participation decision (D_i*)	Acceptable farm-level payment (P_i*) in 1,000€
Nord Pas de Calais	0.018*** (0.018)	-0.687** (0.147)	0.090*** (0.171)	5.331*** (1.127)
Lorraine	0.002 (0.002)	1.384*** (0.296)	0.109*** (0.209)	11.099*** (2.346)
Alsace	-0.003 (0.003)	-0.553* (0.118)	0.102*** (0.195)	6.879*** (1.454)
Franche-Comté	-0.036*** (0.034)	-2.493*** (0.534)	0.093*** (0.177)	2.334*** (0.493)
Pays de la Loire	0.010*** (0.010)	3.487*** (0.747)	0.106*** (0.202)	4.422*** (0.935)
Bretagne	0.058*** (0.056)	3.694*** (0.791)	0.076*** (0.144)	4.179*** (0.883)
Poitou-Charentes	0.038*** (0.036)	2.309*** (0.494)	0.095*** (0.182)	7.269*** (1.537)
Aquitaine	-0.016*** (0.016)	-1.077*** (0.231)	0.101*** (0.193)	5.521*** (1.167)
Midi-Pyrénées	-0.041*** (0.039)	-1.988*** (0.426)	0.095*** (0.180)	6.149*** (1.300)
Limousin	-0.030*** (0.029)	-0.879*** (0.188)	0.099*** (0.189)	4.810*** (1.017)
Rhône-Alpes	0.006* (0.006)	-1.098*** (0.235)	0.104*** (0.197)	4.962*** (1.049)
Auvergne	-0.025*** (0.024)	-2.772*** (0.593)	0.098*** (0.186)	4.780*** (1.010)
Languedoc Roussillon	0.013*** (0.013)	0.718** (0.154)	0.088*** (0.168)	4.867*** (1.029)
Provence-Alpes-Côte d'Azur	0.041*** (0.040)	1.585*** (0.339)	0.071*** (0.136)	2.911*** (0.615)
Corse	Baseline			
Observed participation in AECM in 2015	0.226*** (0.217)	-	-	-
Observed participation in OF support at t-1	-0.025*** (0.024)	0.013 (0.003)	-	-
Observed participation in OF support in 2015	-	-	0.057*** (0.109)	-
Observed participation in AECM at t-1	-	-	-0.010*** (0.018)	0.572*** (0.121)
2016	-0.033*** (0.031)	-0.474*** (0.101)	-0.010*** (0.019)	-0.141 (0.030)
2017	-0.021*** (0.020)	-0.466*** (0.100)	-0.013*** (0.025)	-0.487*** (0.103)
2018	-0.015*** (0.015)	-0.129** (0.028)	-0.016*** (0.030)	-0.428*** (0.091)
2019	Baseline			
ρ	-0.034*** (0.005)	-	0.133*** (0.011)	-
σ	-	5.581*** (0.013)	-	6.978*** (0.020)
Number of observations	28,967	2,442	28,967	1,657
Log-likelihood	-504,317		-318,531	
AIC	1,008,948		637,376	
Schwarz criterion	1,010,826		639,254	
Pseudo-R2 (McFadden)	0.241		0.378	

Significance levels: *** p-value <0.001, ** p-value <0.01, * p-value<0.05, + p-value<0.1. Standard errors in parentheses.
AWU: annual work unit. LU: livestock unit.
Source: own elaboration.

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Exploring macro-environmental factors influencing adoption of result-based and collective agri-environmental measures: a PESTLE approach based on stakeholder statements

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Abstract. To promote more environmentally friendly and cost-effective agri-environmental-climate measures in the European Union, novel approaches such as result-based and collective schemes are advocated. This study explores macro-environmental factors facilitating or impeding the adoption of such schemes. By means of a PESTLE analysis and based on a survey of 85 stakeholders from Austria and Germany, we identify major adoption factors within the political, economic, social, technological, legal, and environmental domains. Our results indicate that economic, legal, and social factors are the most influential, with fair payment, clear contract design, and social relations being the most commonly mentioned. Moreover, the unpredictability of nature is a major impediment to the adoption of result-based schemes, while social dynamics and farmers' attitudes are key factors for a successful implementation of collective contracts. Overall, the study provides strategic and practical insights that can support the design and implementation of novel agri-environmental-climate measures under the Common Agricultural Policy.

Keywords: agri-environmental contracts, German and Austrian stakeholders, survey, acceptance.
JEL Codes: Q15, Q18.

1. INTRODUCTION

A more sustainable agricultural system in the European Union (EU) is not only a societal demand, but also an ecological necessity to tackle climate change, counteract biodiversity loss, and protect the EU's natural resources. By providing public funding, the legal framework of the European Common Agricultural Policy (CAP) has a prominent role in fostering agriculture's

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transition to sustainability. Contracts for Agri-Environment-Climate Measures (AECMs) under the second pillar of the CAP are pluriannual commitments, specifically designed to reduce the negative impacts of agriculture on the environment and to mitigate the effects of climate change (European Commission, 2017). The main challenge for AECMs is to ensure an efficient use of funds in addition to delivering the intended environmental effects. AECMs are facing multifaceted criticisms in this regard, such as the lack of empirical evidence supporting their effectiveness, imprecise targeting through insufficient consideration of the heterogeneity of farms and their local circumstances (European Court of Auditors, 2011), as well as missing (financial) incentives for farmers to produce the best environmental result through their entrepreneurial activity (WBAE, 2020).

New pathways within the design of AECMs are required: approaches such as result-based payments or collective implementation can contribute to a more effective and efficient design of AECMs. Result-based schemes aim at providing environmental improvement through paying for the achievement of specific environmental objectives instead of prescribing and compensating management practices to farmers. Consequently, farmers can flexibly decide how they want to achieve environmental improvement (Burton & Schwarz, 2013). Collective approaches have the objective to activate land managers to jointly provide agri-environmental-climate public goods (AECPGs), often accompanied by formalised cooperation (Runge et al., 2022). In fact, result-based and collective AECMs were eligible for receiving EU co-financing within the past CAP period (2014-2022), although they have been applied to a very limited extent in the Member States (WBAE, 2020). In the new CAP Strategic Plans Regulation ((EU) 2021/2115), Article 70(5), it is recommended that: "Member States may promote and support collective schemes and result-based payment schemes to encourage farmers or other beneficiaries to deliver a significant enhancement of the quality of the environment at a larger scale or in a measurable way." (European Parliament and the Council of the European Union, 2021). Moreover, Recital 71 of Regulation (EU) 2021/2115 states that "[s]upport under payments for management commitments may also be granted in the form of (…) result-based interventions". Result-based payment schemes are further specifically mentioned in the EU's biodiversity strategy 2030 (European Commission, 2020). With the new emphasis on environmental performance in the CAP, result-based schemes gain importance as a fast-evolving and distinctive approach. For illustration, at the time the survey was conducted, a result-based pilot project for nature conservation (biodiversity) was implemented in Austria, which, in the meantime, has been transferred into a fully eligible measure under the Austrian agri-environmental programme for the period 2023-2027 (AMA, 2023). Also in Germany, already in the previous CAP period some Federal States had programmed result-based measures for extensive permanent grassland which now led to the programming of a respective eco-scheme measure targeting flowering species (BLE, 2022). As regards collective approaches, they may operate as an extension of many other forms of contracts aiming at a more effective delivery of environmental goods and services, e.g. at a landscape scale. While in the last CAP period only the Netherlands made extensive use of collective implementation for its agri-environmental schemes, in the new programming period (2023-2027) there are also other countries offering collective measures with CAP funding, e.g. Ireland (DAFM, n.d.) and Germany in the Federal State of Brandenburg (MLUK, 2023).

Still, despite their potential positive impacts on the environmental effectiveness of AECMs, several factors can hinder the implementation and uptake of collective and result-based approaches. The implementation of result-based schemes may be impeded by (i) elevated administrative and transaction costs compared to action-based systems due to the requirement for result measurement, limited experience, and often small-scale experimental designs (Eichhorn et al., 2022; Schwarz et al., 2008), (ii) difficulties in determining accurate indicators for measuring environmental progress (Allen et al., 2014; Burton & Schwarz, 2013); and (iii) potential conflicts with WTO regulations (Matthews, 2019; Melèndez-Ortiz et al., 2009). Factors hampering farmers' willingness to participate are (i) the fear among farmers of lacking sufficient knowledge and skills to successfully perform result-based schemes (Massfeller et al., 2022), (ii) general scepticism towards novel approaches (Stolze et al., 2015), (iii) difficulties in understanding how these contracts work in practice (Wezel et al., 2018), (vi) perceived higher risk due to environmental uncertainty, and (vii) no secured remuneration (Derissen & Quaas, 2013). Also collective approaches face hurdles, such as lack of farmers' willingness to cooperate (Franks, 2011), insufficient coordination (Olivieri et al., 2021), and missing of pre-existing networks or lack of capacity (Prager, 2022).

Up to now, the state of knowledge on factors supporting or hindering the implementation of novel schemes is largely based either on case studies investigating mostly single or few contract solutions in a specific context (e.g. Birge et al., 2017; de Sainte Marie, 2014; Derissen & Latacz-Lohmann, 2013; Prager, 2022; Zabel, 2019), on farmers' surveys mainly addressing farmers'

intention to perform such novel schemes (e.g. Massfeller et al., 2022; van Dijk et al., 2015), or on studies concentrating on contract related factors, such as contract design features (contract length, payment mode etc.) (Bredemeier et al., 2022; Schulze & Matzdorf, 2023).

What is still missing, however, is a structured gathering of knowledge about macro-environmental factors influencing the adoption of result-based and collective agri-environmental measures. This is where this study comes in. Macro-environmental factors (such as technological, political, natural factors) refer to external forces and conditions that can have a significant impact on a business or organisation's operations and performance and are beyond the control of the business, but can influence its success or failure (Kotler et al., 2018). In our case, we looked at factors, which cannot be influenced by farmers directly, but have an impact on farm business decisions. A PESTLE analysis framework was used to identify these macro-environmental factors that promote or hinder the implementation of novel contract types in a holistic, structured and multidisciplinary way (Yüksel, 2012). Our analysis is based on an online survey of 85 stakeholders from Austria and Germany conducted in spring 2021. Within this survey, stakeholders identified a comprehensive set of factors based on six PESTLE categories (Political, Economic, Social, Technological, Legal, and Environmental). The survey targeted a wide range of stakeholders involved in the promotion, design, implementation and control of AECMs, with actors from government agencies, environmental organisations, agricultural associations, and private sector companies. By including policy makers/administrators/advisors from local up to national level, we were able to gather strategic, as well as practical (phenomenological) knowledge (Raymond et al., 2010).

The importance and originality of this study is that it (1) compares two novel contractual AECM approaches in one analysis, (2) strongly focuses on the opinion of stakeholders on external factors, which are much less examined within the agriculture policy literature and (3) provides a structured analysis of the external factors by applying the PESTLE approach, a strategic tool from business analysis, for the first time to study AECMs.

2. DATA AND METHOD

Our study aimed at identifying topics potentially affecting the adoption of result-based or collective contracts in their operational environment. For this purpose, the PESTLE approach was applied. This strategic planning tool is regularly used to analyse external macro-environmental factors that may impact an organisation or industry (Gupta, 2013). It is often used in marketing as well as for strategic business decisions (Theobald 2019), however, also in other fields the PESTLE tool (or its previous model PEST) is gaining importance (Achinas et al., 2019; Gupta, 2013; Rambaree et al., 2021). "PESTLE" represents the initial letters of the six factor categories considered, namely Political, Economic, Social, Technological, Legal, and Environmental factors. The main advantages of the PESTLE approach are, that it (1) enables a holistic, multidisciplinary analysis of the external factors inhibiting or promoting the feasibility of result-based or collective contract solutions before they are put into practice (precondition analysis) (Yüksel, 2012), (2) improves decision-making by systematically providing valuable information (in our case phenomenological and strategic stakeholder knowledge) and thereby encourages strategic thinking (Nitank & Treivdi, 2016) and (3) enhances risk assessment, by identifying potential risks that impact the feasibility and implementation of new types of contracts, thereby helping to take actions to avoid or minimise their effect (Nitank & Treivdi, 2016).

2.1 Questionnaire and data

Surveys were conducted in Austria and Germany between end of April and mid-May 2021[1] to assess stakeholders' knowledge of external factors impacting the implementation of novel AECMs. The surveys were administered online via LimeSurvey. Potential participants were contacted via email and provided with an online-link to access the survey. We aimed to reach key stakeholders and actors (e.g. involved in the promotion, design, implementation and control of AECMs), targeting respondents acting in different roles or having different areas of interest from both the public and private sector and with different backgrounds, at local, regional, and state levels. In Austria, 80 stakeholders were contacted and 34 questionnaires completed, in Germany, 142 persons were contacted and 51 completed surveys were received. This led to a total of 85 surveys considered in the analysis. Among the stakeholders, due

[1] Within the CONSOLE project, a stakeholder survey with PESTLE questions about the result-based contract was carried out in 12 countries. However, only Germany and Austria also conducted a PESTLE survey for collective contracts. In this contribution, we will, therefore, solely refer to the survey results from Germany and Austria. For more information on the PESTLE results for the 12 countries, see Hamunen et al. (2023): Deliverable 3.3 "Synthesis of opinions to implement suggested contract solutions and lessons learned" on the CONSOLE-website at www.console-project.eu.

to the still rather experimental nature of such schemes, an overall low level of familiarity with result-based and collective approaches was assumed. Connected to this, and for ensuring some common understanding amongst respondents, a short description of result-based as well as collective contract solutions was included in the survey (see appendix A). The questionnaire was structured into three parts: the first part contained questions on the respondent's backgrounds, such as affiliation, areas of interest, and responsibilities. The PESTLE approach was then implemented using two blocks of questions (one for result-based and one for collective approaches). The PESTLE block began with the overarching question of what external factors in the farm environment inhibit or promote the adoption of (a) result-based or (b) collective contracts? For a better understanding, participants were shown the six main PESTLE categories in a figure (see Fig. 1). Additionally, PESTLE categories were described by including short examples/descriptions: namely 1) environmental factors such as emissions and climate change, 2) political factors such as administration and regulations, 3) economic factors such as purchasing power and income, 4) socio-cultural factors such as demographic development and societal demands, 5) technological factors such as digitalization and innovations, 6) legal factors such as environmental and competition law.

The procedure of the survey was then as follows: Starting with result-based and in a second round continuing with collective contracts, participants were asked to (1) name 5 particularly important factors impacting on implementation/adoption, which can't be influenced by farmers directly, but have an impact on farm decisions. As participants were informed about the PESTLE categories beforehand, they certainly kept them in mind when answering, but they were not asked to name the factor nor to assign their responses to any category. (2) Using the symbols "+" or "-", participants were asked to indicate whether the mentioned factors promote or hinder implementation. (3) In a final ranking exercise, participants were then asked to select the most important factor out of the 5 answers they had given. This resulted in 5 responses for each contract type, of which one each was selected as most important for both result-based and collective contracts.

There was no word limit for the free answers but participants were asked to answer in short sentences, supplemented by the note: "the more concrete the information, the better". In addition, participants were forced to provide five responses, otherwise they were not able to continue the survey. The approach used is illustrated exemplarily in Table 1 in appendix A.

Figure 1. PESTLE categories; figure showed in the survey.

2.2 Data analysis

The analysis of the PESTLE results was carried out in excel and by using a three-step approach: First, the factors named by the stakeholders were assigned to the 6 PESTLE categories. This was done separately for the two contract types. (Thereby, statements which referred to the design of the contracts themselves, such as contract terms, duration etc. were assigned to the legal category.[2]) Second, factors representing a similar content were grouped, examined and subcategories were built. Thereby, a minimum of 3 associated responses were required to form a subcategory. To ensure quality and improve objectivity, the allocation of single factors to the subcategories was conducted via several rounds of exchanges between the Austrian and German researchers involved in the study. Third, codes and short summarising descriptions were assigned to the subcategories, whereas codes represent the PESTLE category and a consecutive number (e.g. "Ec" for Economic factor and "04" for the fourth subcategory). As several identical factors were mentioned by the stakeholders for both types of contracts, subcategories were summarised under identical descriptions where possible. Differences in subcategory descriptions between the two contract types are underlined in Table 1 for ease of identification and

[2] Several contract-related responses, in most cases targeting particular contract features, were given by the stakeholders, therefore the legal category was expanded to include them.

– whenever the descriptions differ partly or completely – abbreviations, CO for collective and RB for result-based, are added to the respective codes (e.g. Ec04RB)). Differences in subcategories are often closely related to the specificities of the two contract solutions under consideration.[3] When responses couldn't be assigned to one specific subcategory – either because they highlight interfaces or because they address aspects belonging to two different subcategories – a double-code was given (e.g. Ec01/L06), but they were only assigned (and counted) within the first code. For the case that stakeholders' answers directly repeated the pre-set PESTLE category, (e.g. stakeholders stated that economic factors influence adoption), such responses were counted into the respective PESTLE category, but were not assigned to any subcategory and marked "00". To reduce the complexity of the interpretation of the external factors we formulated descriptions of the subcategories neutrally or positively.

3. RESULTS

3.1 Descriptive statistics of stakeholder characteristics

Among the Austrian respondents, most participating stakeholders (64.7%) were active on a national level. In Germany mainly regionally (56.3%), and nationally active stakeholders (29.2%) participated in the survey. With regard to the field of activity, "agricultural activity" is in first place in both countries, followed by "environmental protection and nature conservation" and "forestry". In Germany 68.6% and in Austria 60.4% of the surveyed stakeholders are employed in these three fields of activity, whereby multiple answers were possible (Figure 2).

While in Austria many participating stakeholders (30%) were representatives of the private sector, a large share of German stakeholders were representing state organisations (22.9%). Furthermore, representatives of public companies, non-governmental organisations, scientific institutions, non-profit organisations, associations and civil society took part in the survey. In both countries, "advice or provision of information for farmers" was the most important task or field of interest for the participating stakeholders. Thus, 23.3% of the stakeholders in Austria and 21.2% in Germany were active in this area. For 21.6% and 14.7% of stakeholders in Austria and Germany, respectively, this task was also the most important field of activity. In Austria, "support in the design of contract solutions" (21.4%) and "provision of information to the public" (19.4%), were the second and third most important areas of activity, both of which were selected by 20.6% of the respondents. Also, in Germany, these tasks were named second and third most frequently, however in reverse order (for more details on stakeholder characteristics please see Appendix B).

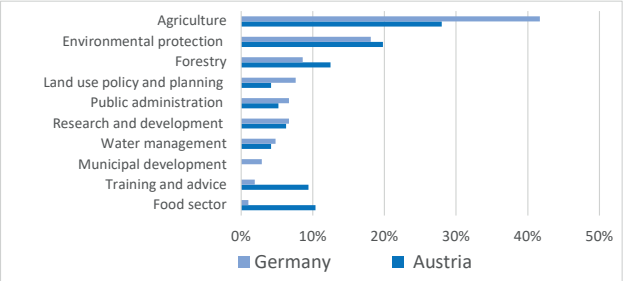

Figure 2. Stakeholders' fields of activity in Austria and Germany.

4.2 PESTLE Results

For result-based contracts, a total of 376 responses could be assigned to the six PESTLE categories, of which 147 came from Austrian and 229 from German stakeholders. For collective contracts, a total of 333[4] responses could be assigned to the six categories (131 from Austria, 202 from Germany). Table 1 summarises the main findings: The title of each section represents the PESTLE category. Subcategories (codes and descriptions) are assigned to each category, with differences between result-based and collective contract types being underlined. For each category, between four and six subcategories have been formed. Table 1 also serves as basis for the results presented in chapters 4.2.1 and 4.2.2. A more detailed description of the results is provided in Table 4 in Appendix C, which, in addition to the descriptions for all subcategories, also indicates the frequency of mentions and the factors selected in the ranking exercise as most important. In addition, it is indicated if the factor mentioned was marked as promoting or hindering.

Figure 3 shows how the factors identified for result-based and collective contracts are distributed across the six categories and among the two countries. The total number of responses per country and contract type is 100%, distributed across the six PESTLE categories.

[3] This is most evident for the social category, where the responses of stakeholders were assigned to different headings with one exception (see Table 1).

[4] The different amount of answers between collective and result-based schemes can be explained by the fact that only those factors which can't be influenced by farmers themselves while having an impact on farm decisions were included. Furthermore, within the collective part (the third part of the survey) a few participants decided to just write "no additional idea/answer" into the field.

Table 1. PESTLE categories and subcategories built based on the survey responses

POLITICAL		ECONOMICAL	
P01	Advice and support to farmers for implementation	Ec01	Payment calculation, appropriate remuneration for participation in the contracts
P02	Political will to support farmers in delivering environmental services	Ec02RB	Availability of sufficient funding for contract payments
		Ec02CO	Availability of sufficient funding for contract payments and for coordination / measure planning
P03	Low level of bureaucracy and administrative burden	Ec03	Income / revenue security and little financial risk for farmers
P04	Longer-term stable political framework	Ec04RB	Reliability of demand for and value chains to sell the agricultural products
		Ec04CO	Sharing of remuneration between farmers when participating in the contracts
P05	Assistance in contract implementation by qualified authorities and intermediaries	Ec05	New income opportunities for farmers by participating in contracts
		Ec06	Limited time and financial effort for implementation
SOCIAL		TECHNOLOGICAL	
S01	Social appreciation, recognition for the environmental services provided by farmers	T01RB	Existence of appropriate technologies for measuring the results achieved
		T01CO	Existence of appropriate technologies for measuring the achievements
S02RB	Attitudes of farmers, consideration of cultural norms and traditions	T02	Determination of appropriate indicators for monitoring
SO2CO	Attitudes of farmers and sensitivities of farmers		
S03RB	Societal and consumers' demand and interest for environmental services	T03	Easy to implement and no time-consuming monitoring / documentation
S03CO	Involvement of further stakeholders (interest groups, ...)		
S04RB	Willingness to work together (interest groups, neighbours, farmers' associations)	T04RB	Access to technology / machinery, technical practicability
		T04CO	Access to technology / machinery, distribution of work
S04CO	Content of cooperation		
S05RB	Farmers' awareness of environmental topics and knowledge	T05RB	Sufficient knowledge about the environmental effects of the farming practices
S05CO	Farmers' awareness of environmental topics and knowledge exchange		
S06CO	Group dynamics		
LEGAL		ENVIRONMENTAL	
L01RB	Contract characteristics: voluntariness, flexibility, clear goal(s), possibility of influencing	En01	Impacts of climate change and perceived need for action
L01CO	Contract characteristics: voluntariness, flexibility, clear goal(s), entry and exit conditions, responsibilities		
L02RB	Simplicity and comprehensibility of the contract	En02	Unpredictability of nature and the limited ability of farmers to have an influence on it
L02CO	Conditions of participation for farmers (number, setting)		
L03	Clarity and consistency of the legal framework of the contract	En03	Spatial and regional environmental conditions
L04	Compatibility of the contract with existing laws, programs and EU policies	En04	Interplay of action and impacts on nature and environment
L05	Practical achievability of the contract goals		
L06	Transparent and comprehensible controls and sanctions		

Note: PESTLE category = title; Subcategories including codes (category and a consecutive number e.g. Ec01, if different: CO= collective; RB= result-based, deviating wording is underlined).

In general, the figure reveals that stakeholders from both countries have given similar preferences to certain PESTLE categories per contract type, resulting in a similar distribution of the responses.

Results also show that general differences exist between the importance of specific PESTLE categories

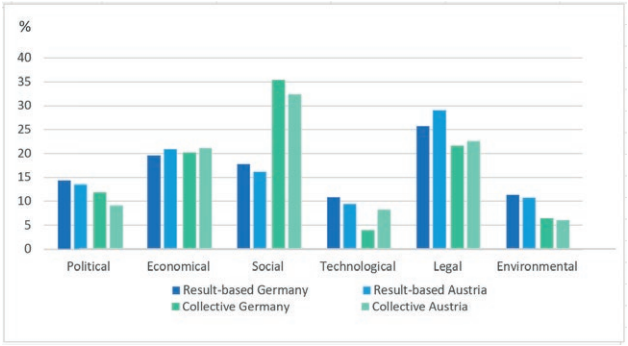

Figure 3. Breakdown of all stakeholder responses to the six PESTLE categories per contract type and country. Note: The six PESTLE categories for each contract type by country sum up to 100%.

with respect to specific contract types: For result-based contracts, most stakeholder responses belonging to this contract type fall into the legal category, with 25.8% for Germany, respectively 29.3% for Austria. The economic category with around 20% is placed second, social third and political fourth.

For collective contract solutions, stakeholder responses belonging to the social category take the biggest share with 35.5% of the responses from Germany, respectively 33.1% from Austria, followed by the legal category on the second, and economic on the third place.

Differences between both countries amongst categories become obvious only for the political category in respect to collective contracts, which is considered as more important by German than by Austrian stakeholders. Also, for collective contracts concerning the technological category some variance occurs: here German stakeholders evaluate technological aspects as less important than the Austrian respondents do.

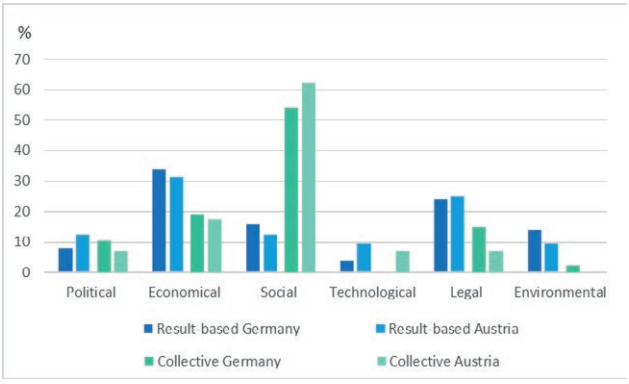

Figure 4. Breakdown of the responses ranked as most important by the stakeholders to the six PESTLE categories per contract type and country. Note: The six PESTLE categories for each contract type by country sum up to 100%.

When looking at the responses which were ranked as most important and their distribution amongst the six PESTLE categories, differences between the two contract types become even more explicit (see Figure 4). For result-based contracts, the economic category received the highest number of responses marked as "most important". 34% of the German and 31.3% of the Austrian stakeholders selected a response belonging to the economic category. For result-based contracts, the legal category follows on the second place with 24% of the German, respectively 25% of the Austrian responses ranked first. In sum, more than 50% of the responses ranked as most important for result-based contracts belong to those two categories. For the collective contract the dominance of the social category is outstanding, with 54.2% of the answers from Germany and 62.1% of the Austrian answers ranked as most important. At a great distance follows the economic category with less than 20% in both countries.

4.2.1 External factors in result-based contracts

In the following section, all six PESTLE categories impacting on **result-based contracts** are described, following the PESTLE order[5]. However, since economic, legal and social factors were mentioned most frequently for result-based contracts and since these are also the factors differing most when comparing the responses for result-based and collective contract solutions, more emphasis is put on these factors. An overview of the most mentioned subcategories in result-based contracts can be found in Table 2 at the end of this sub-chapter.

– *Political factors impacting result-based contracts*

In the political PESTLE category for result-based contracts, the subcategory **low level of bureaucracy and administrative burden** (P03) includes 11 individual stakeholder statements. Within these 11 statements, the factors "*administrative effort*"[6] *and* "*bureaucracy*" have been mentioned four times each. One stakeholder, for example, expressed concerns that result-based contracts would lead to an increase in bureaucracy due to the customization required for each contract to match the specific environment. Nine

[5] Due to the very similar response behaviour of the stakeholders, an evaluation in chapter 4.2.1 and 4.2.2 is carried out without differentiation between the two countries. However, where there are visible differences in response behaviour between Austria and Germany, this is addressed and highlighted in the result section.

[6] All translations of the responses from German to English by the authors.

statements were summarised under the subcategory of **political will to support farmers in delivering environmental services** (P02). One stakeholder stated that the "*contents of the contracts must have political consensus*". In the third place, with 8 statements, the subcategory of **advice and support to farmers for implementation** (P01) emerged. Advice, including technical guidance, and access to training are considered promoting factors. One stakeholder for example stated the need for "*support in understanding what is worth protecting and why*".

– *Economic factors impacting result-based contracts*

In the economic PESTLE category, the subcategory of **payment calculation, appropriate remuneration for participation in the contracts** (Ec01) was built on a sum of 28 statements, representing the subcategory based on most stakeholder responses within the whole PESTLE analysis for result-based contracts. Also, for the factors ranked as most important, this subcategory received the highest number (12 mentions). The payment level itself has been mentioned several times as an important factor for participation ("*It must pay off for the farmer*"). At the same time, it was critically noted that the payment calculation is "*demanding*". Also costs and time required for the payment calculation have been mentioned as economic factors. Listed as encouraging was that result-based contracts allow for a "*reward for higher environmental standards*" and also that the "*payments are positively dependent on management/commitment*". Specifically, a "*fair design of payment*" is called for, and this was made even more explicit in the response that "*fair compensation creates acceptance and reliability.*" In this sense, one stakeholder suggests a combination of "*basic remuneration plus performance payment (participation + success)*", while another participant advocates "*gradations in the achievement of intermediate targets*". In the economic category, 12 statements could be assigned to the subcategory of **new income opportunities for farmers by participating in contracts** (Ec05) placed second. On the third place, out of 10 statements, the subcategory **income / revenue security and little financial risk for farmers** (Ec03) emerged. While the former subcategory focuses on economic opportunities, the latter focuses on the risks associated with result-based contracts. Several times, economic profitability was mentioned in Ec05, with seven factors being ranked as most important under this subcategory. Thereby, the environmental performance to be provided was also considered. One statement explained that "*It must be possible to realize a financial and ecological profit that can be economically influenced on the basis of entrepreneurial decisions.*" Price fluctuations or the price level of the cultivated crops, but also production-related mistakes are mentioned as factors that can put at risk the income for participating farmers.

– *Social factors impacting result-based contracts*

In the social PESTLE category compiling factors with relevance for result-based contracts, the subcategory of **social appreciation, recognition for the environmental services provided by farmers** (S01) is based on 20 statements. Thus, it became clear that public perception or appreciation is classified as promoting. One statement in this respect exclaimed "*noticeable (!) social recognition*" as a factor, and another marked that "*the performance should be made visible to the people*". In addition, there were also a few sceptical voices about result-based contracts in the social context namely that "*The more differentiated the requirements are, the more difficult it is to argue 'externally' the funding level or to explain to the consumer what exactly is being done*". The importance of outreach to improve social recognition was highlighted in four responses. For example, one statement said that "*society needs to be made aware of this important work of the farmer through the media*". 15 further statements have been compiled under the subcategory of **farmers' awareness of environmental topics and knowledge** (S05RB). As promoting factors, farmers' own initiative and responsibility in result-based contracts have been mentioned: For example, one statement was that "*farmers are granted expertise/partners in nature conservation*". In the social category, the **attitudes of farmers, consideration of cultural norms and traditions** (SO2RB)**,** but also the **willingness to work together (interest groups, neighbours, farmers' associations)** (SO4RB) and the **societal and consumers' demand and interest for environmental services** (SO3RB) further emerged from the stakeholders' answers. Even if result-based contracts are implemented on the level of individual farms, peer pressure or social pressure from other farmers can have both positive and negative effects. An answer expressing positive impacts in this respect was for example that "*experience of other farmers with result-oriented contracts influences the acceptance and willingness to participate of interested parties*".

– *Technological factors impacting result-based contracts*

In the technological PESTLE category for result-based contracts, **existence of appropriate technologies for measuring the results achieved** (T01RB) has emerged as the only subcategory addressed more frequently, assembling 13 responses. Participants suggested new technologies, such as drones, remote sensing or aerial photography. One answer says for example that

Table 2. Result-based contracts – subcategories with at least ten mentions.

	Code	Subcategory	Sum	+	-	1.	P	Ec	S	T	L	En
1	Ec01	Payment calculation, appropriate remuneration for participation in the contracts	28	21	7	12						
2	En02	Unpredictability of nature and the limited ability of farmers to have an influence on it	27	3	24	8						
3	L01	Contract characteristics: voluntariness, flexibility, clear goal(s), possibility of influencing	22	21	1	4						
4	L06	Transparent and comprehensible controls and sanctions	20	8	12	3						
5	S01	Social appreciation, recognition for the environmental services provided by farmers	20	17	3	2						
6	L03	Clarity and consistency of the legal framework of the contract	18	12	6	4						
7	S05	Farmers' awareness of environmental topics and knowledge	15	14	1	4						
8	L04	Compatibility of the contract with existing laws, programmes and EU policies	14	5	9	3						
9	T01	Existence of appropriate technologies for measuring the results achieved	13	11	2	2						
10	Ec05	New income opportunities for farmers by participating in contracts	12	10	2	7						
11	L05	Practical achievability of the contract goals	12	10	2	4						
12	P03	Low level of bureaucracy and administrative burden	11	4	7	3						
13	Ec03	Income / revenue security and little financial risk for farmers	10	1	9	1						

Sum = number of responses in total assigned under this heading/factor; + = responses framed positively as well as assigned as promoting factor; – = responses framed negatively as well as assigned as hindering factor; 1. = number of responses, stated as most important factor for result-based contracts by stakeholders in the survey = ranking exercise; categories: P = Political ; Ec = Economical; S = Social; T = Technological; L = Legal; En = Environmental.

"*a possible documentation of results by the farmer could be facilitated by an app*", another recognizes that "*by all means use digitalization for knowledge creation and control, certainly motivates the majority*". In the technological category, reliability of outcome measurement, the choice of easily measurable indicators, and the availability of technology, both for monitoring and for measure implementation are further crucial factors. One suggestion in this respect was that "*easy-to-use tools should be available for documentation/monitoring*". Another answer going in the same direction by telling that, "*it is also important that technological means are promoted and made available to farmers through appropriate knowledge transfer on advantages and disadvantages*". Opportunities are further seen in digitalization and the use of special technology.

– *Legal factors impacting result-based contracts*

Within the legal PESTLE category**,** the subcategory of **contract characteristics** (L01) was highly important for the stakeholders, being represented by 22 statements. Here, voluntariness, flexibility and clear goals were named as promoting factors. The importance of achievable goals or a form of co-determination in the setting of goals becomes clear with these two answers: "*objective benefit of the goals should be evident to the contracting parties*" and "*if farmers can influence the selection of the desired ecological goals, this promotes acceptance*". Also, "*quantitative and qualitative specification of the results (criteria, indicators)*" is seen positively. This requirement is closely related to suitable technical feasibility and was coded twice accordingly (L01RB/T02). Another subcategory within the legal PESTLE category, which was built on 20 statements is **transparent and comprehensible controls and sanctions** (L06). While sanctioning is seen as a factor hindering the implementation of result-based contracts, controls and controllability were rated both positively and negatively. Annual fluctuations, especially with regard to biodiversity, insects, etc., are seen as critical for the assessment of results. In this regard, one question raised was "*What happens if, for example, no species settle/no results can be shown?*" As possible solutions, "*easy to control (simple success criteria)*" as well as "*conciliation in case of differing assessments of success*" were mentioned. The third important subcategory within the legal category, with 18 statements as basis, is **clarity and consistency of the legal framework of the contract** (L03). "*Legal certainty*" and "*planning security*" were mentioned particularly often with 6, respectively 4 responses. The 2 subcategories of **compatibility of the contract with existing laws, programmes and EU policies** (L04) and **practical achievability of the contract goals** (L05) were built on 14 and 12 statements, respectively. In connection with legal regulations, restrictions due to requirements from the fertilizer regulation and the prohibition of double funding were mentioned. Demands such as "*achieving the agreed results*

must not lead to sovereign protection!" or "*no obligation to continue after termination of the contract*" point to existing legal uncertainties in ecological successes.

– *Environmental factors impacting result-based contracts*

The environmental PESTLE category assembles the second most statements for result-based contracts under the subcategory of **unpredictability of nature and the limited ability of farmers to have an influence on it** (En02). This subcategory was built based on 27 statements in total, and 8 statements ranked as most important. Weather conditions and extreme weather events such as lack of precipitation have been mentioned, which can negatively influence the results and thus jeopardize the success of the measures implemented. Also addressed are uncertainties in natural processes, population trends, as well as already good ecological status as a baseline, which can make further environmental improvements difficult. From the point of view of the stakeholders, dealing with these uncertainties is crucial for a successful implementation of result-based contracts. This became clear e.g. in the demand that "*in case of extreme weather, the farmer must also be compensated*" (En02 / Ec01) or in the question on "*liability in case of non-achievement of goals (capricious weather, ...)*" (En02 / L06). The double coding indicates that regulations in this regard are highly relevant from an economic as well as a legal perspective. The subcategory of **impacts of climate change and perceived need for action** takes a special position within the environmental PESTLE category (En01). Climate change was explicitly mentioned as a factor relevant for result-based schemes, so one statement was for example that "*effects of climate change are felt by every farmer and increase the willingness to deal with the topic of soil*". One stakeholder commented that "*paid environmental or ecosystem services are farm diversification and increase resilience in climate change.*"

4.2.2 External factors in collective contracts

For collective contracts, we again structured the results along the six PESTLE categories. A clear dominance of social factors became obvious for collective contracts. Also, legal and economic factors were mentioned often, therefore we describe these three categories in more detail. Table 3 at the end of the chapter provides an overview of the twelve subcategories with most statements assigned to collective contracts.

– *Political factors impacting collective contracts*

As in the case of result-based contracts, within the political PESTLE category for collective contracts, the subcategory **low level of bureaucracy and administrative burden** (P03) was the only category to be built on the basis of more than 10 stakeholder statements. Hereby arguments concerning efficiency and effort have been raised: Stakeholders mention that in collective contract solutions "*control effort for [the] authority could be reduced*", and that "*public admin costs are reduced and increased within the group, but more efficient*". Also mentioned positively was that "*administration has fewer individual applications to deal with*". However, there are also a number of responses indicating the risk of even more bureaucracy for this contract type. This shows that the contractual arrangement will be decisive for the amount of bureaucracy. In the ranking process two responses within this category have been selected as most important, namely that "*good information in advance about the measure, its practical implementation and about ecological bases*" needs to be provided (within subcategory P01) and "*political will must be present*" (within subcategory P02).

– *Economic factors impacting collective contracts*

The most important subcategory within the economic PESTLE category impacting on the adoption of collective approaches is the **fair sharing of remuneration between farmers when participating in the contracts** (Ec04CO): Many statements take up the issue of fair payment distribution and how this can be organized. One stakeholder for example raised the question "*how is the compensation and the distribution within the group realised?*" and one respondent put his/her fears in a nutshell as follows: "*distribution of payment – when it comes to money, friendship ceases*". Other stakeholders suggested a "*distribution formula*" as well as the "*distribution of money via third parties*" or a "*pre-allocation of the remuneration*" in order to avoid disputes. But there were also comments regarding how to consider differences in cost structure amongst participating farms and how to distribute money fairly. Besides fair remuneration, two further economic aspects, summarised in the subcategories **payment calculation, appropriate remuneration for participation in the contracts (Ec01)** (13 statements) and **new income opportunities for farmers by participating in contracts (Ec05)** (11 statements) revealed to be of high importance for successful collective contracts. Of the 13 answers on payment calculation, 9 came from Austria, one of the rare situations with a clear country difference in the response behaviour. As in the case of the result-based contracts, statements on the payment amount and "*proper financial incentive*" dominate; there is also the demand for "*payment also for the additional organisational effort*" in the case of collective measures. In the ranking process,

for collective contracts 16 statements in the economic category were selected as most important, while for the result-based contracts 28 statements in the economic category were chosen. Amongst the most important factors were the requests for "*financing a coordination function*" and "*coordination must not be at the expense of remuneration*".

– *Social factors impacting collective contracts*

In the ranking of all PESTLE categories, for collective contracts social subcategories take the second to fourth place. This clearly demonstrates the outstanding relevance given to them by the stakeholders inquired (see Table 3). 30 statements have been assigned to the subcategory of **attitudes and sensitivities of farmers** (S02CO). Moreover, 13 stakeholders ranked statements in this subcategory as the most important, bringing it in the first position. For example, a good neighbourly relationship, "*past experiences of cooperation between farmers*" and the "*alliance of farmers with the same goal*" are mentioned as conducive. However, a number of inhibiting factors are also mentioned. For example, the willingness of farmers to cooperate and exchange is doubted, one answer in this respect was that a "*farmer is rather a loner*". But also, envy and jealousy between farmers or "*difficulty in finding a group"* have been mentioned. Trust between farmers, fairness, willingness to communicate and the ability to work in a team are mentioned as prerequisites for the successful implementation of collective contract solutions. The subcategory of **content of cooperation** (S04CO) follows in third place with 29 statements, of which the positive mentions slightly outweigh with 16 answers. 10 responses within this subcategory were ranked as most important by the stakeholders. Particularly the setting of common goals was mentioned several times as an important success factor, thereby e.g. two answers stated that "*the group focuses on a few or a common goal*" and "*farmers can achieve this effectively and on a large scale as a group with a common goal*". Coordination and communication efforts within the "collective" are seen as obstacles to be overcome, answers underlying this statement are e.g. that a "*common basis for discussion between all participants at equal level*" is needed, or, formulated differently, that there must be "*no dependencies / power imbalances within the group*". An "*equitable distribution of duties and benefits in the collective*" is seen as a success factor and it was suggested to offer "*mediation and conflict resolution training*". It was noted that "*if collective structures already exist, this simplifies the process*". The possibility of exchanging experiences among each other is seen positively, but also that in collective contracts synergies can arise. **Group dynamics** (S06CO) were considered as a separate subcategory, as 21 responses explicitly refer to it, 9 of which were ranked as most important. In total, this term was used six times by the respondents, of which it was negatively evaluated five times. For example, group dynamics are described as a "*stumbling block*" and there is a fear that solutions are endangered "*if individual participants crossfire*"; there are also questions about how to deal with social conflicts within the group as well as with "*difficult characters*". Specifically addressed is the concern that "*individual interests or political opinions of group members differ greatly or diverge*" and "*free-riding*" is mentioned as a further problem. Promoting factors are if the "*group [is] already sufficiently long established*", the presence of group members who have an "*exemplary character for other participants*" and the emergence of a "*we-feeling*". In the case of the subcategory of **social appreciation, recognition for the environmental services provided by farmers** (S01), with one exception, only promoting factors are mentioned. One statement explains that "*as a group it is easier to present interests to the outside world (public, politics)*", and also the "*example setting for third parties outside the group*" is mentioned. For the success of collective contracts, the **involvement of further stakeholders** (S03) besides farmers is important. Hereby, advisors and agricultural associations were explicitly mentioned, but also cooperation with environmental administrations/ authorities was suggested. With regard to the involvement of nature conservation associations, answers were more reserved with a "*distrust of environmentalists*" being mentioned and the potential for conflict that this may entail.

– *Technological factors impacting collective contracts*

Within the technological PESTLE category, even though none of its subcategories was amongst the top twelve, stakeholders raised a number of concrete suggestions: For example, "*technical devices that facilitate the application or the implementation of measures*" or technical solutions for the "*clear breakdown of services and rewards*" and for the "*verifiability of results and allocation to individual farmers*" are seen as beneficial. One stakeholder calls for "*suitable (digital) tools for the documentation of the measures implemented*". Also, the use of GPS "*can positively influence coordination within the collective*".

– *Legal factors impacting collective contracts*

For collective contracts, amongst the legal PESTLE category, the subcategory **contract characteristics: voluntariness, flexibility, clear goal(s), entry and exit**

Table 3. Collective contract solutions – subcategories with at least ten mentions.

	Code	Subcategory	Sum	+	-	1.	P	Ec	S	T	L	En
1	L01	Contract characteristics: voluntariness, flexibility, clear goal(s), entry and exit conditions, responsibilities	34	18	16	4					■	
2	S02	Attitudes and sensitivities of farmers	30	9	21	13			■			
3	S04	Content of cooperation	29	16	13	10			■			
4	S06	Group dynamics	21	8	13	9			■			
5	Ec04	Sharing of remuneration between farmers when participating in the contracts	18	3	15	4		■				
6	L03	Clarity and consistency of the legal framework of the contract	14	8	6	3					■	
7	Ec01	Payment calculation, appropriate remuneration for participation in the contracts	13	11	2	1		■				
8	Ec05	New income opportunities for farmers by participating in contracts	11	10	1	2		■				
9	S03	Involvement of further stakeholders (interest groups, ..)	10	8	2	2			■			
10	S01	Social appreciation, recognition for the environmental services provided by farmers	10	9	1	3			■			
11	P03	Low level of bureaucracy and administrative burden	10	4	6	3	■					
12	L06	Transparent and comprehensible controls and sanctions	10	5	5	0					■	

Sum = number of responses in total assigned under this subcategory/factor; + = responses framed positively as well as assigned as promoting factor; – = responses framed negatively as well as assigned as hindering factor; 1. = number of responses, stated as most important factor for collective contracts by stakeholders in the survey = ranking exercise; categories: P = Political ; Ec = Economical; S = Social; T = Technological; L = Legal; En = Environmental.

conditions, responsibilities (L01CO) was in first place with 34 stakeholder statements belonging to it. The contractual regulation of responsibilities and accountabilities, as well as clear rules and a clear distribution of tasks are named as promoting factors. Stakeholders ask questions such as "*how is the contract with the agency structured?", "who selects criteria for performance*", "who evaluates which achievements with distribution of funds?", "*how is the division of labour organized within the group*", or "*who is liable if an individual from the collective fails to perform*". Several answers in this subcategory refer to the legal protection in case of changes in the group composition or if one or more participants want to leave. The necessity of a clear formulation of goals is further stated, also that this is more difficult in the case of collective contracts as it requires "*contractual clarification between farmers*". The risk for disputes is mentioned as an inhibiting factor, either "*in the in the contract negotiations*", or because of "*unfulfilled requirements of individuals*" or regarding "*the payout*"; in this regard, there is a suggestion to establish an "*internal control system in the collective*". 14 stakeholder statements built the legal subcategory of **clarity and consistency of the legal framework of the contract** (L03). As with result-based contracts, also with collective solutions legal and planning certainty are addressed, and there is the concern about "legal dispute(s) when drafting the contract."

In addition, 10 statements were addressed to the subcategory of **transparent and comprehensible controls and sanctions** (L06), classified under legal aspects even though being relevant from economic perspective too. Central is thereby the question of "*how is the cooperation regulated, what happens if repayments would have to be made*". In the same direction goes the statement that the "*collective must be secured in terms of a control and sanction system*". There is also concern about the "*risk of sanctions or assumption of liability for mistakes made by other farms*". At the same time, another stakeholder points to an advantage of collective contracts with the answer "*no feeling as an individual to be at the mercy of the control system*".

– *Environmental factors impacting collective contract solutions*

In the environmental PESTLE category for collective contracts, in contrast to the result-based contracts, no subcategory made it into the top twelve. Beneficial factors addressed in this category are however the "*higher effectiveness of measures*" and that "*regional concerns can be better addressed*". Mentioned is moreover the possibility for implementing measures in a larger area through collective contracts and that the "*integration of structures such as wind belts etc. [is] more easily possible*". Qualifying, one response reads "*suitable only for measures that have a landscape effect and not just an area-specific effect.*" One comment is "*if it is clear what characterises a region and what is worth protecting, everyone is on board*".

5. DISCUSSION AND CONCLUSIONS

This work addresses macro-environmental factors impacting on the success of result-based contracts, and of contracts fostering collective implementation, both aiming for an improved provision of agri-environmental-climate public goods. So far, to the knowledge of the authors, only little literature can be found on hindering or facilitating external factors affecting the implementation of these novel AECMs. Therefore, this study aimed to investigate political, economic, social, technological, legal as well as environmental factors by using the PESTLE approach. The analysis was based on a stakeholder survey conducted in Germany and Austria.

The application of the PESTLE approach has demonstrated its efficacy as a valuable tool for structuring and classifying the varied responses elicited from a diverse set of stakeholders. It could be demonstrated that stakeholders possess the ability to provide input within the established categories/factors. Nevertheless, the practical application of the PESTLE approach within this particular context has encountered certain limitations. First, it is important to recognize that the quality of the results obtained is highly depending on which stakeholders finally participate in the survey. Despite successfully engaging a significant number of stakeholders in both countries, it is important to note that the sample is not representative in terms of their regional level (e.g., with a bias towards regional and national stakeholders), background organisation, and other stakeholder characteristics (see Appendix B). Second, our study specifically addressed factors that are beyond the direct control of farmers, yet exert influence on their business decisions. Under the CAP, AECM contracts are standardized and not subject to bilateral negotiations, thereby restricting individual contractors from negotiating specific elements of contract design within the legal framework. Consequently, various "internal" design elements arise within the "external" legal category (e.g. L01 contract characteristics), rendering the precise differentiation between "external" and "internal" factors somewhat challenging. Third, a lack of clear demarcation between external and internal factors was observed within the social category. While there are distinct external social factors such as social appreciation, this category also encompasses subgroups that can be regarded as internal, namely farmers' awareness and attitudes. Taking a broader perspective, it can be argued that the external social environment plays a pivotal role in shaping and influencing farmers' awareness and attitudes. Fourth, in the case of collective contracts, the introduction of a third social interaction in the form of the "group dynamics" of course represents a significant differentiation within the subcategories of collective and results-oriented contracts (e.g. S04CO "content of cooperation" and S06CO "Group dynamics" versus S04RB "willingness to work together (interest groups, neighbours, farmers' associations"). This has led to significant distinctions within the social category for result-based and collective contract solutions and to different subcategory headings, with one exception.

The results of this analysis shall now be discussed along the main external factors revealed for both contract types (see table 2 and 3). Starting with the factors/subcategories that exhibit congruence across both contract types, we will conclude with those factors that demonstrate the most significant variations in terms of statements and subcategories.

Navigating uncertainty in the new CAP period – political factors

During our PESTLE analysis, conducted in the midst of the new Common Agricultural Policy (CAP) strategic planning discussions, it became evident that the upcoming CAP period has resulted in considerable uncertainty among German and Austrian stakeholders. The respondents frequently highlighted the importance of having a clear and consistent legal framework for the contracts, as well as ensuring that the contracts are compatible with existing laws, programs, and EU policies. Specifically, legal certainty, planning security, ongoing legal changes, and the potential issue of double funding were identified as key concerns.

Fair payment structures and new income opportunities – economic factors

The economic category plays a crucial role in both result-based and collective schemes. The appropriate remuneration for participation and the potential for new income opportunities are perceived highly positive and important for farmers' engagement among stakeholders in both types of contracts. AECMs representing an additional income opportunity is a well-known motivational factor among famers in classical schemes, but was also already confirmed in novel schemes (e.g. Barghusen et al., 2021). The calculation of payments, however, is a concern for stakeholders in result-based contracts due to the challenge of compensating appropriately for the environmental improvements achieved. Literature recommends tailoring the payment structure to the environmental objective and the level of participation desired (Herzon et al., 2018). Stakeholders suggest

incorporating intermediate targets or offering graduated payments for various levels of success. The importance of fair economic incentives in introducing existing and novel contract types is widely acknowledged (Lastra-Bravo et al., 2015; Pavlis et al., 2016; Ruto & Garrod, 2009; Wilson & Hart, 2000), and should also cover risks in the introductory phase (Prager & Posthumus, 2010). In collective contracts the fair distribution of payments in line with the management efforts is particularly relevant for adoption. In addition, a "collective bonus" could serve as a reward for the additional effort of the farmers to integrate their business orientation into a specialised (collective) concept (DVL, 2021).

Beyond money: the power of social recognition in incentivizing environmental services by farmers – social factors

In addition to economic incentives, social appreciation and recognition for the environmental services provided by farmers are perceived as strong promoting factors in both result-based and collective schemes. Farmers react to societal demand when delivering AECPGs, but this usually goes along with higher / additional workload. Making farmers' work visible, for example through media or public relations work, helps improving the image of agriculture and is perceived as a strong promoting external factor. Result-based schemes, in addition, provide an opportunity to report clear environmental results to society. Furthermore, farmers themselves have also emphasized the importance of social recognition (Russi et al., 2016), which was mirrored by our stakeholder responses.

Stakeholders expressed concerns about specific contract design elements, with clearly differentiated requirements for result-based and collective contracts – legal factors

In line with the reticence and concerns expressed by stakeholders, there are recommendations pertaining to the legal aspects of contract design. While in result-based schemes, voluntariness, flexibility, and clear goals are key aspects, for collective schemes, entry and exit conditions as well as responsibility issues are particularly relevant. This finding is consistent with previous research suggesting that collective incentive schemes should have clearly defined participation criteria and organisational structures (Barghusen et al., 2021; Franks, 2011). Additionally, stakeholders emphasized the importance of fair distribution of remuneration among farmers participating in collective schemes, and a third-party distribution system or pre-allocation of the remuneration were suggested as means to increase trust and fairness. The legal category also revealed that stakeholders call for legal protection in case of changes in group composition. In literature, result-based schemes promote higher flexibility in farmers' management decisions (de Sainte Marie, 2014; Klimek et al., 2008; Matzdorf & Lorenz, 2010; Russi et al., 2016; Sabatier et al., 2012), and this was also deemed important by the stakeholders. In addition, result-based schemes require clear targeting, which involves a precise definition of the results that farmers can achieve and the ability to influence them, according to our stakeholders.

Nature's unpredictability poses a significant hindrance to result-based agri-environmental schemes – environmental factors

According to the results of our study, the unpredictability of nature and the limited influence of farmers on it emerged as a major hindering external factor for the adoption of result-based contracts. This issue is very specific to result-based schemes, where linking payments to measurable environmental improvements makes the influence of nature more salient, particularly in direct comparison to the dominating action-based payments. Also, for collective contract solutions it was seen as less relevant. Already existing literature has identified this issue as a potential risk factor for result-based payments (de Snoo et al., 2013; Derissen & Quaas, 2013; Olivieri et al., 2021; Wezel et al., 2018), our study provides evidence of its significance in stakeholders' perception: In the survey, stakeholders identified and mentioned various environmental factors that can influence the ecological outcome, including extreme weather events, seasonal/regional weather phenomena/conditions, shifts in animal and plant communities, climatic conditions, soil conditions, and the current ecological status. Thus, stakeholders acknowledge that the achievement of ecological results is not solely in the hands of farmers.

Social dynamics and farmer attitudes: Key factors in collective contracts – social factors

For collective contracts, social relationships between participating farmers and the related difficulties are dominating stakeholders' perceptions when thinking about hindering and facilitating external factors. This resulted in "attitudes and sensitivities of farmers" being the aspect with the most statements, and it also ranked first in the list of factors rated as most important. Farmer-to-farmer relationships and the social dimension of

such engagements were frequently mentioned. Promoting factors included past positive experiences of cooperation between farmers, good neighbourly relations, and an existing basis of trust. Hindering factors included a lack of willingness to cooperate, jealousy, traditions, and the perception of farmers as "loners". The stakeholders' predominantly pessimistic view of farmers' willingness to cooperate is also mirrored in a study by Rommel et al. (2022). Already Sutherland et al. (2012) concluded to take farmer co-ordination with caution, especially with regard to social characteristics and assumptions about trust between farmers. They also noted that it seems useful to build on existing structures. Franks (2011) stated that the success of collective contracts depends on clubs of like-minded members with similar views and beliefs who are willing to cooperate and have a low level of conflict between the members. Stakeholders in our study specifically addressed group dynamics as a crucial factor. They identified difficulties in bundling diverse interests and managing larger groups but saw positive aspects in knowledge exchange, developing a group feeling ("together we protect!"), and possible social control. Other studies have shown that farmers are motivated to join a group for knowledge exchange, learning from peers, and socializing with other farmers (Prager, 2022). Also Barghusen et al., (2021) confirmed social norms as an motivation factor.

6. CONCLUDING REMARKS AND OUTLOOK

To sum up, the objective of this study was to investigate the factors that are outside the sphere of influence of the individual farmer impacting the adoption of novel agri-environmental schemes, specifically result-based and collective schemes, using the PESTLE analysis framework. This approach was conducted to provide a systematic analysis of the macro-environmental factors affecting the implementation of such schemes and to offer in-depth insights. The study adopted a stakeholder survey approach and collected precise, multidisciplinary, and holistic insights into most important external factors. The findings of this study can support the decision-making of Austrian and German policymakers in the design and implementation of the two novel contract types by considering relevant promoting factors, including practical requirements for result-based and collective contract approaches from the outset. Furthermore, the study identified hindering factors that could be used as a basis for risk assessment, and scheme designers could act to minimize or avoid their impact. Overall, this study shows the suitability and practicality of the PESTLE approach for analysing the external factors influencing agri-environmental policy measures. This is becoming even more important under the current CAP with its new green architecture that gives greater flexibility at Member State level in the choice and design of measures targeting the environment and climate.

Further research opportunities are seen within the framework of the approach adopted in this study. One pathway to follow in future investigations could be the examination and comparative analysis of responses from further countries and assessing the differences amongst them. Moreover, it would be important to quantitatively analyse more in depth the differences between external factors for result-based compared to external factors for collective contracts. Another promising area for future research is to look more closely at the stakeholders and actors, their background and their activities at different levels and how this influences their response behaviour.

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APPENDIX A
DESCRIPTIONS OF RESULT-BASED AND COLLECTIVE CONTRACTS AS PROVIDED WITHIN THE PESTLE SURVEY

Result-based contract

In a result-based contract, land managers receive a **payment only for the delivery of environmental or climate results** (e.g. water protection, landscape improvement, increasing biodiversity of carbon sequestration). Land managers are free to decide about the management practices, with which they want to achieve these environmental or climate improvements. Selected indicators and scoring systems to monitor environmental or climate results are often used, and they will be exactly defined in the contract. Land managers have access to advice or training when they participate in this contract and they can voluntarily engage in the monitoring activity.

Contract with collective implementation

Land managers become members of **a group who applies jointly for compensation in order to implement environmental or climate activities**, e.g. water protection, carbon sequestration, biodiversity or landscape improvement. A minimum number of group members (e.g. 5) from the region is required to collaborate in order to get a payment. The group members decide about the implementation and locating the measures, and the distribution of the payment. Within the group, peer land managers and advisors share knowledge and support the achievement of the environmental objectives.

Table 1. Approach used within the PESTLE survey, exemplarily illustrate for RB schemes.

<table>
<tr><td colspan="4">(1) Short introduction into the PESTLE task</td></tr>
<tr><td colspan="4">(2) Overarching question of the PESTLE survey stated</td></tr>
<tr><td colspan="4">(3) Introduction of the six PESTLE factors including short descriptions and the PESTLE figure 1
 
</td></tr>
<tr><td colspan="4">(4) Short contract solution descriptions for result-based contract and contract with collective implementation provided</td></tr>
<tr><td colspan="4">(5) Participants are asked to name five 5 important aspects, influencing the implementability, in short concrete statements (example given)</td></tr>
<tr><td colspan="4">Please name 5 important aspects that, in your view, influence the implementability of RB/CO contracts , in short concrete statements.</td></tr>
<tr><td>A</td><td colspan="3">free text 1</td></tr>
<tr><td>B</td><td colspan="3">free text 2</td></tr>
<tr><td>C</td><td colspan="3">free text 3</td></tr>
<tr><td>D</td><td colspan="3">free text 4</td></tr>
<tr><td>E</td><td colspan="3">free text 5</td></tr>
<tr><td colspan="4">(6) Participants are asked to decide for each response given if it is promoting or hindering and to finally select the response considered as most important (example)</td></tr>
<tr><td rowspan="2">Your list of aspects (transferred from above A - E)</td><td colspan="2">Is the aspect promoting or hindering the adoption?</td><td>The most important (only one)</td></tr>
<tr><td>promoting
+</td><td>hindering
-</td><td>1.</td></tr>
<tr><td>A free text 1</td><td>☑</td><td>☐</td><td>☐</td></tr>
<tr><td>B free text 2</td><td>☐</td><td>☑</td><td>☐</td></tr>
<tr><td>C free text 3</td><td>☑</td><td>☐</td><td>☐</td></tr>
<tr><td>D free text 4</td><td>☐</td><td>☑</td><td>☐</td></tr>
<tr><td>E free text 5</td><td>☐</td><td>☑</td><td>☑</td></tr>
</table>

APPENDIX B – CHARACTERISTICS OF THE AUSTRIAN AND GERMAN STAKEHOLDERS

Table 2. Characteristics of the Austrian and German stakeholders.

Characteristics		Germany frequency (%)	Austria frequency (%)
Regional level of the respondent	National	29,2	64,7
	Regional	56,3	20,6
	Local	14,6	0
	International	0	14,7
Background organisation	Civil society / Private individual	4,2	0
	Public enterprise	8,3	17,6
	Non-governmental organisation	8.3	8,8
	Academic (e.g. university, research institute)	8,3	17,6
	Non-profit organisation (e.g. foundation, association)	14,6	11,8
	Private company	18,8	32,4
	Governmental organisation	22,9	8,8
	Other (e.g. professional associations)	14,6	2,9
Special area of responsibility (multiple answers allowed)	Agriculture	41,9	28,1
	Environmental protection / nature conservation	18,1	19,8
	Forestry	8,6	12,5
	Land use policy and planning	7,6	4,2
	Public administration	6,7	5,2
	Research and development	6,7	6,3
	Water management	4,8	4,2
	Community development	2,9	0
	Training and advice	1,9	9,4
	Food sector	1,0	10,4
Role or areas of interest (multiple answers allowed); in bracket selection of "most important"	Provider of information/advice to farmers	21,2 (21,6)	23,3 (14,7)
	Provider of information to the public	19,2 (13,7)	19,4 (20,6)
	Assistance for public funding of land management	1,9 (2,0)	4,9 (0)
	Support in the design of contract solutions	14,4 (17,6)	21,4 (20,6)
	Equipment and/or tool provision	7,7 (0)	2,9 (2,9)
	Providing/leasing land to land managers	2,9 (0)	4,9 (5,9)
	Providing finance to land managers/owners/workers	5,8 (2)	3,9 (0)
	Regulation and enforcement	6,7 (5,9)	2,9 (0)
	Lobbying, campaigning	13,5 (17,6)	6,9 (2,9)
	Community leader	1,9 (2)	1,9 (2,9)
	Supervisory authority	1,9 (2)	3,9 (0)
	Product certification body (e.g. organic, …)	0 (0)	0 (0)
	Processor of agricultural products	1 (2)	3,9 (2,9)
	Trade with agricultural products	1,9 (0)	0 (0)
	No selection "most important"	(15,7)	(26,5)

Table 3. Federal state from which the participants originate (in %).

Germany	Stakeholder	Austria	Stakeholder
Baden-Württemberg	5,9	Burgenland	6,06
Bavaria	13,7	Lower Austria	12,12
Berlin	5,9	Upper Austria	6,06
Brandenburg	2,0	Salzburg	0
Hamburg	3,9	Styria	3,03
Hesse	5,9	Tyrol	0
Mecklenburg-Western Pomerania	5,9	Vorarlberg	0
Lower Saxony	5,9	Vienna	30,30
North Rhine-Westphalia	21,6	Across the federal states	42,42
Rhineland-Palatinate	7,8		
Saarland	0		
Saxony	2,0		
Saxony-Anhalt	2,0		
Schleswig-Holstein	7,8		
Across the federal states	9,8		

APPENDIX C

Table 4. Detailed overview of subcategories mentioned within the PESTLE approach.

Code	Subcategory	CT	Sum	+	-	1.	P	E	S	T	L	E
P00	Political category – without specification	RB	5	2	3	1						
		CO	6	0	6	0						
P01	Advice and support to farmers for implementation	RB	8	7	1	1						
		CO	8	8	0	3						
P02	Political will to support farmers in delivering environmental services	RB	9	8	1	1						
		CO	3	3	0	1						
P03	Low level of bureaucracy and administrative burden	RB	11	4	7	3						
		CO	10	4	6	3						
P04	Longer-term stable political framework	RB	6	3	3	0						
		CO	4	2	2	0						
P05	Assistance in contract implementation by qualified authorities and intermediaries	RB	7	6	1	2						
		CO	5	4	1	0						
P06RB	Extensive communication of the measures to the public and to farmers	RB	7	7	0	0						
Ec00	Economical category – without specification	RB	8	5	3	4						
		CO	7	4	3	4						
Ec01	Payment calculation, appropriate remuneration for participation in the contracts	RB	28	21	7	12						
		CO	13	11	2	1						
Ec02RB	Availability of sufficient funding for contract payments	RB	4	3	1	2						
Ec02CO	... and for coordination / measure planning	CO	8	6	2	2						
Ec03	Income / revenue security and little financial risk for farmers	RB	10	1	9	1						
		CO	6	5	1	3						
Ec04RB	Reliability of demand for and value chains to sell the agricultural products	RB	6	4	2	1						

(Continued)

Table 4. (Continued).

Code	Subcategory	CT	Sum	+	-	1.	P	E	S	T	L	E
Ec04CO	Fair sharing of remuneration between farmers when participating in the contracts	CO	18	3	15	4						
Ec05	New income opportunities for farmers by participating in contracts	RB	12	10	2	7						
		CO	11	10	1	2						
Ec06	Limited time and financial effort for implementation	RB	8	2	6	1						
		CO	6	2	4	0						
S00	Social category – without specification	RB	7	6	1	0						
		CO	6	4	2	2						
S01	Social appreciation, recognition for the environmental services provided by farmers	RB	20	17	3	2						
		CO	10	9	1	3						
S02RB	Attitudes of farmers, consideration of cultural norms and traditions	RB	9	5	4	2						
S02CO	Attitudes of farmers and sensitivities of farmers	CO	30	9	21	13						
S03RB	Societal and consumers' demand and interest for environmental services	RB	8	5	3	2						
S03CO	Involvement of further stakeholders (interest groups, ...)	CO	10	8	2	5						
S04RB	Willingness to work together (interest groups, neighbours, farmers' associations)	RB	5	1	4	1						
S04CO	Content of cooperation	CO	29	16	13	10						
S05RB	Farmers' awareness of environmental topics and knowledge	RB	15	14	1	4						
S05CO	… and knowledge exchange	CO	8	7	1	2						
S06C	Group dynamics	CO	21	8	13	9						
T00	Technological category – without specification	RB	7	7	0	1						
		CO	3	3	0	0						
T01RB	Existence of appropriate technologies for measuring the results achieved	RB	13	11	2	2						
T01CO	Existence of appropriate technologies for measuring the achievements	CO	8	7	1	1						
T02	Determination of appropriate indicators for monitoring	RB	5	3	2	0						
		CO	1	1	0	0						
T03	Easy to implement and no time-consuming monitoring / documentation	RB	3	2	1	0						
		CO	1	1	0	0						
T04RB	Access to technology / machinery, technical practicability	RB	7	3	4	1						
T04CO	Access to technology / machinery, distribution of work	CO	6	4	2	1						
T05RB	Sufficient knowledge about the environmental effects of the farming practices	RB	4	2	2	1						
L00	Legal category – without specification	RB	7	1	6	2						
		CO	5	4	1	0						
L01RB	Contract characteristics: voluntariness, flexibility, clear goal(s), possibility of influencing	RB	22	21	1	4						
L01CO	… and entry and exit conditions, responsibilities	CO	34	18	16	4						
L02RB	Simplicity and comprehensibility of the contract	RB	9	5	4	0						
L02CO	Conditions of participation for farmers (number, setting, ...)	CO	6	1	5	1						
L03	Clarity and consistency of the legal framework of the contract	RB	18	12	6	4						
		CO	14	8	6	2						
L04	Compatibility of the contract with existing laws, programmes and EU policies	RB	14	5	9	3						
		CO	2	0	2	0						

(Continued)

Table 4. (Continued).

Code	Subcategory	CT	Sum	+	-	1.	P	E	S	T	L	E
L05	Practical achievability of the contract goals	RB	12	10	2	4						
		CO	3	3	0	2						
L06	Transparent and comprehensible controls and sanctions	RB	20	8	12	3						
		CO	10	5	5	0						
En00	Environmental category – without specification	RB	5	3	2	1						
		CO	4	3	1	0						
En01	Impacts of climate change and perceived need for action	RB	4	2	2	0						
		CO	2	2	0	0						
En02	Unpredictability of nature and the limited ability of farmers to have an influence on it	RB	27	3	24	8						
		CO	5	2	3	0						
En03	Spatial and regional environmental conditions	RB	3	0	3	0						
		CO	7	5	2	1						
En04	Interplay of action and impacts on nature and environment	RB	3	2	1	1						
		CO	3	2	1	0						

Note: Table 4 shows categories and subcategories including sum of all answers, indication of promoting or hindering assessed answers, weighting exercise answers with number of weighted as most important: Sum = number of responses in total assigned under this subcategory/factor; + = responses framed positively as well as assigned as promoting factor; – = responses framed negatively as well as assigned as hindering factor; 1. = number of responses, stated as most important factor for collective or result-based contracts by stakeholders in the survey = ranking exercise; categories: P = Political ; Ec = Economical; S = Social; T = Technological; L = Legal; En = Environmental.

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Innovative contract solutions for the Agri-Environmental-Climate Public Goods provision: Which features meet the farmers' approval? Insights from Emilia-Romagna (Italy)

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Abstract. The agroecological transition promoted worldwide is supported by the European Union Common Agricultural Policy towards different strategies and policy tools. The agri-environmental schemes, offering farmers the possibility to adopt environment-friendly practices (thus mitigating negative externalities/providing positive ones) represent a straightforward example. However, there is dissatisfaction about their effectiveness and efficiency, while their improvement is envisaged through a flexible mix of new instruments: novel contract solutions fostering result-based payments, collective implementation, involving value chains and land tenure systems coupled to environmental conditionality. This paper investigates how farmers from Emilia-Romagna (Italy) perceive these innovative contract solutions as "easy to understand", "applicable", "economic beneficial", and their willingness to enroll. The applied ordered logistic regression models include socio-demographic characteristics, structural features of the holdings, and the farmers' preference(s) for 13 individual contract features. Farmers' perceptions are driven by the previous experience acquired from similar measures, key socio-demographic characteristics/holding structural features, and peculiar contractual elements.

Keywords: public goods, result-based, collective approach, value chain, land tenure.
JEL codes: Q15, Q20, Q57.

1. INTRODUCTION

An agroecological transition[1] is being promoted worldwide through the UN 2030 Agenda for Sustainable Development (United Nations, 2015) and

[1] Agroecological transition corresponds to a systemic transformation generated by the ecologisation of agriculture and food. It concerns multiple actors among farmers, supply chains, natural resource managers, policymakers, etc. and it is characterized by the fact that a deliberate political intention

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in particular in the European Union (EU) through its Common Agricultural Policy (CAP) and the European Green Deal (Baldock and Buckwell, 2021; European Commission, 2019).

Among the CAP strategies and policy tools, the most popular instrument is the eco-conditionality embedded in the indirect subsidies (Mamine et al., 2020) which makes the payment conditional on the uptake of a set of actions considered appropriate for reducing negative externalities or improving positive ones (Hanley et al., 2012; White and Hanley, 2016). Complementary to that, the agri-environmental schemes (AESs) funded by the CAP are based on payments to farmers for the uptake of environment-friendly practices and the provision of ecosystem services that go beyond conditionality. AESs are a compulsory element of the EU Member States rural development plans (RDP) design but are voluntary for farmers. Their relevance lies in the mandatory share of funds allocated to co-financing: 30% of CAP Pillar II (supposed to grow in the future).

A large body of literature considers AESs, assessing their agri-environmental-climate effects (see Hasler et al., 2022 and the references therein), analyzing their cost-effectiveness and efficiency (Ansell et al., 2016; Bartolini et al., 2021; Blazy et al., 2021; Drechsler et al., 2017; Pacini et al., 2015), estimating the effects on the agricultural holdings structure and productive choices (Arata and Sckokai, 2016; Bertoni et al., 2020; Chabé-Ferret and Subervie, 2013; D'Alberto et al., 2018; Mennig and Sauer, 2020), and detecting the factors that influence farmers' uptake decision and behavior (Brown et al., 2021; Drechsler, 2021; Gailhard et al., 2015; Raina et al., 2021; Vergamini et al., 2020).

Despite this abundant literature and the knowledge on AESs, there is dissatisfaction about their effectiveness and efficiency in delivering agri-environmental-climate public goods (AECPGs[2]) and in terms of achievements longevity (Biffi et al., 2021; Bullock et al., 2021). Nowadays, AESs are largely dominated by action-based approaches addressing individual farmers, while their improvement is envisaged through a flexible mix of new instruments (Herzon et al., 2018; Olivieri et al., 2021), such as contract solutions fostering result-based payment schemes or collective implementation, and solutions involving value chains and/or implementing new forms of land tenure systems coupled to environmental conditionality. These novel approaches are expected to provide AECPGs in a more efficient and effective way, being compliant with what is envisaged by the Farm to Fork strategy and the EU Biodiversity Strategy for 2030. The former is at the heart of the European Green Deal that aims at making Europe the first climate-neutral continent by 2050. It plans to reduce the environmental and climate footprint of the EU food system by addressing comprehensive challenges in terms of sustainability towards a transition that ensures that the whole food chain has a neutral or positive environmental impact (European Commission, 2020a). The latter strongly supports such a transition by acknowledging that it cannot be successfully achieved without restoring the endangered ecosystems, "bringing nature back to agricultural land" (European Commission, 2020b). Both initiatives strongly support and incentivize the transition to fully sustainable practices.

To the best of our knowledge, some of these new incentive approaches have been mainly investigated individually, like the result-based payments – the most studied instrument so far – (Birge et al., 2017; Russi et al., 2016; Sidemo-Holm et al., 2018; Šumrada et al., 2022, 2021; Zabel, 2019) and the collective approaches (El Mokaddem et al., 2016; Narloch et al., 2017; Westerink et al., 2017), while land tenure contracts with environmental clauses and the initiatives along the value chain were seldom addressed by the literature.

This paper investigates four novel contract solutions for the AECPGs provision: result-based (RB), collective (Co), value chain (VC), and land tenure (LT) contracts. These contract types are analyzed in terms of farmers' acceptability and willingness to uptake, by assessing:

1) The farmers' perception of the easiness of understanding related to the innovative contract solution.
2) The farmers' perception of the contract's applicability in the farm.
3) The farmers' perception of the economic benefit deriving from the contract.
4) The farmers' willingness to enroll.

The preferences concerning these points are explained using the socio-demographic characteristics of the farmers/land managers and the structural features of the agricultural holdings. The paper also focuses on the assessment of the influence that 13 individual features that define the contract solutions can play in determining the farmers' preferences. Data are collected by means of an online survey carried out within the EU CONSOLE Project[3] among the farmers of Emilia-Romagna (Italy).

is willing to bring such a transformation to move towards a more sustainable agricultural and food system (Magrini et al., 2019).

[2] These are non-rival, non-excludable goods provided by agriculture and forestry with direct implications in terms of (potential) positive externalities for both climate and environment (e.g., carbon sequestration, air and water quality and quantity, soil restoration/maintenance, etc.) (Cooper et al., 2009).

[3] The CONSOLE Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 817949. For further details: https://console-project.eu.

The novelty of the paper lies in 1) the investigation of farmers' perceptions of four new, incentive contract types that combine a flexible mix of new instruments; 2) the inclusion in the modeling exercise (in addition to the socio-demographic characteristics of the farmer as well as the structural features of the agricultural holding) of the information about the farmers' preferences for several individual features characterizing these instruments; 3) the application of ordered logistic regression that, to the best of our knowledge, has never been applied to analyze farmers' preferences for AECPGs contracts.[4] Ordered logistic regression models are rather solid (Agresti, 2019, 2010), but the so-called partial proportional odds/non-parallel lines modelling approach has only recently attained a cohesive formalization (Williams, 2006; Yee, 2010). The main, recent innovation consisted in their expansion for allowing the relaxation of its key assumption, the "proportionality of the odds" (Williams, 2016). The latter states that a respondent operates a proportional shift when evaluating his/her preferences for the levels depicted by the categorical outcome variable. In other words, the assumption states that the "distance" in terms of individual's preferences between a lower level of the categorical outcome variable and a higher one, is proportional for all the levels of such a variable. It has been demonstrated that violations of this assumption frequently occur in practice and they have been nimbly disregarded (Brant, 1990; Long and Freese, 2014; Xu et al., 2022), hence leading to biased and mis-interpretable results (Agresti, 2010). This is not the case of the present work. Indeed, we test the proportionality of the odds and relax the assumption when needed. This relaxation allows for avoiding biased estimates by properly depicting the shift of individual's preferences among the different levels of the categorical outcome variable, applying the partial proportional odds model when there is no proportionality of the odds about the levels of preference.

The results hint at the influence that previous experience (acquired from very similar measures), key socio-demographic characteristics, and structural features of the holding play in driving the farmers' perceptions of the easiness of understanding, applicability, and economic benefit of the contract solutions, as well as their willingness to enroll. In addition, the above-mentioned perceptions can be influenced by peculiar contractual elements, not only those straightforwardly linked to the identification of the contract type.

The paper is structured as follows: section 2 presents the research framework, the case study, the data at hand, and the statistical method. Section 3 presents the results, while in section 4 we discuss them. Finally, section 5 hosts the conclusions.

2. DATA AND METHODS

2.1 Case study

The Emilia-Romagna region is located in Northeastern Italy. The southern part is hilly and includes the mountainous areas of the Apennines, while the southern part of the Po River plain dominates the northern portion of the territory. The plains are characterized by intensive agriculture and arable crops, the hills by vineyards and orchards, and the mountains mainly by grasslands, arable crops, and woods. The plain area is highly urbanized, while the mountainous areas are marginalized and characterized by land abandonment.

Data on Emilia-Romagna citizens were collected online, using Qualtrics, from May to July 2021 with a questionnaire promoted on the institutional website of the Emilia-Romagna region dedicated to Agriculture (Regione Emilia-Romagna, 2022a) and on the corresponding official Facebook page (Regione Emilia-Romagna, 2022b), allowing respondents to freely access the Qualtrics link. 559 questionnaires were initiated, of which 305 completely answered questionnaires (55%) are used for the present analysis. Table 1 depicts the main descriptive statistics of the sample.

2.2 Questionnaire overview

The survey questionnaire (D'Alberto et al., 2022) is based on two parts: the first collects the socio-demographic characteristics of the respondent and the main characteristics of the agricultural holding he/she manages/owns; the second focuses on the contract solutions. First, we investigated the respondent's preference(s) for 13 individual features that potentially define a generic environmental programme/contract. Secondly, information on the respondent's preference about the four contract solutions (RB, Co, VC, LT) was collected, specified in terms of "understandability", "applicability" in the farm, and "economic benefit". Finally, the respondent was asked about his/her willingness to enroll.

Table 2 depicts the 13 individual contract features with their definitions, built on the findings from the scientific literature review on the subject (Eichhorn et al., 2020) in combination with the insights gathered from the discussion of such findings among (and with) the

[4] A similar application (logit modelling), but targeting AESs is offered by Gailhard and Bojnec (2015).

Table 1. Descriptive statistics of the sample.

Explanatory variable	Nr. of observations	Percent	Q1, Median, Mean, Q3 (Standard Deviation)
Gender			
male	264	86.56 %	
female	41	13.44 %	
Age			
18-30	29	9.51 %	
31-40	42	13.77 %	
41-50	67	21.97 %	
51-60	104	34.10 %	
61-70	41	13.44 %	
>71	22	7.21 %	
Educational level			
primary	74	24.26 %	
secondary	156	51.15 %	
university or higher – BA's, MA's, Ph.D. or equivalent	75	24.59 %	
Membership			
none	149	48.85 %	
farmers union	108	35.41 %	
nature conservation/ environmental organization	48	15.74 %	
Proportion of holding sales – to processor			
0 %	213	69.84 %	
1-30 %	38	12.46 %	
31-60 %	14	4.59 %	
61-100 %	40	13.11 %	
Proportion of holding sales – to private wholesaler/retailer			
0 %	139	45.57 %	
1-30 %	58	19.02 %	
31-60 %	25	8.20 %	
61-100 %	83	27.21 %	
Proportion of holding sales – to cooperatives			
0 %	193	63.28 %	
1-30 %	21	6.89 %	
31-60 %	21	6.89 %	
61-100 %	70	22.95 %	
Proportion of holding sales – direct to final consumer			
0 %	228	74.75 %	
1-30 %	37	12.13 %	
31-60 %	15	4.92 %	
61-100 %	25	8.20 %	
Specialization			
arable	136	44.59 %	
horticulture	15	4.92 %	
permanent	84	27.54 %	
livestock	32	10.49 %	
mixed	38	12.46 %	

(Continued)

Table 1. (Continued).

Explanatory variable	Nr. of observations	Percent	Q1, Median, Mean, Q3 (Standard Deviation)
Organic production			
no	232	76.07 %	
yes	73	23.93 %	
Utilized Agricultural Area owned – in hectares			5.5, 18, 62.41, 40 (191.57)
Utilized Agricultural Area rented in – in hectares			0, 9, 49.67, 45 (188.81)
Direct CAP payments			
no	60	19.67 %	
yes	245	80.33 %	
RDP payments – Euro			
no	115	62.30 %	
yes	190	37.70 %	
Previous experience			
no	205	67.21 %	
yes	100	32.79 %	

Note: Q1 = 1st quartile; Q3 = 3rd quartile.

European stakeholders (Viaggi et al., 2020b).[5] These features were selected since they potentially characterize, in general, an agri-environmental programme/contract and, at the same time, for being specifically distinctive of one (or more) incentive contract solution. For example, "the payment gets higher, the better your environmental results are" specifically fits to result-based contract solution. However, this contractual element can be part of a collective-based incentive or a solution involving the value chain. Therefore, the features are not explicitly linked to a contract type, while each of them can regard a specific aspect of the contract. Finally, as per the stakeholders' suggestions and insights, the 13 features help in framing the general idea of the innovative contract solutions in the most understandable way for the EU farmers/land managers, disregarding their experience(s) with the CAP agri-environmental-climate measures (AECMs).

The features in Table 2 were presented to the respondent as general attributes of a hypothetical agri-environmental contract/programme. Before describing RB, Co, VC, and LT contract solutions in detail, the respondent was asked: *"How much would the following characteristics of agri-environmental contracts increase or decrease your willingness to enroll to an environmental contract or programme?"*. The possible answers (Likert scale) were: 1 = "Decreases my willingness considerably", 2 = "Somewhat decreases my willingness", 3 = "No effect on my willingness", 4 = "Somewhat increases my willingness", 5 = "Increases my willingness considerably".

Table 3 depicts the descriptions of the four contract solutions offered to the respondent (Viaggi et al., 2020a, 2020b).

After each short description of the contract, the respondent was asked: *"How do you see this contract type? Do you agree or disagree with the following statements?"*. The three statements were: *"Easy to understand"*, *"Applicable for my farm"*, and *"Potentially economically beneficial for my farm"*. The respondent was asked to express an opinion where 1 = "Strongly Disagree", 2 = "Disagree", 3 = "Neutral", 4 = "Agree", 5 = "Strongly Agree".

Finally, for each specific contract solution (RB, Co, VC, LT) the respondent was asked: *"How likely is that you would enroll in a* –name– *contract type in the future?"* (the answers were 1 = "Very Unlikely", 2 = "Unlikely", 3 = "Neutral", 4 = "Likely", 5 = "Very Likely").

Considering the contract features presented in Table 2, Figure 1 depicts the distribution of the scores that have been given by the respondents to the 13 individual contract features.

As per Figure 1, there are individual contract features that relevantly influence, in a positive way, the

[5] The literature review found and analyzed 58 existing case studies within and outside the EU. A survey among project partners and stakeholders and a workshop addressing 105 stakeholders from 11 EU Member States and the United Kingdom were held for discussing, selecting, and debating the most promising examples.

Table 2. Individual contract features.

Contract feature	Definition
Self-chosen measures	In the contract, you are free to decide about the management practices to achieve the specified environmental result(s).
Better results, higher payment	The payment gets higher, the better your environmental results are.
Collective agreement	You can collectively agree on environmental targets and measures at landscape-level together with other land managers/forests owners.
Common payment	You and other land managers (farmers/forests owners) receive a common payment. You jointly agree on the distribution of the payment.
Labelled product	You sell your holding's products labelled as environmentally friendly (e.g., animal welfare products, climate friendly products) when following management measures as prescribed in a processor or retailer contract.
Paid by customers	The contract is not paid by public money, instead the compensation that you get for environmentally friendly production is paid by buyers of your products.
Reduced land rent	You can lease land with a reduced rent, if you agree to follow environmental management clauses as specified in the lease contract.
Self-monitoring	You can do the monitoring of the environmental results yourself (e.g., count specific plants).
Control by authority	The results that you achieve are regularly controlled by the competent authority coming onto your farm, e.g., once per year.
Free training or advice	You are offered free training and advice that enables you to reach the environmental targets.
Sales guarantee	You get a sales guarantee from a processor or retailer in return for implementing environmental measures.
Annual compensation	You get environmental compensation payment on an annual basis.
Periodical payment	You get half of the environmental payment at the beginning of, e.g., the five-year contract, and half at the end of it.

Table 3. Contract solutions descriptions.

Contract solution	Description
Result-based	In a result-based contract you receive a **payment only for the delivery of environmental or climate results**. You are **free in your decision about the management practices**, e.g., how to contribute to water protection, landscape improvement, biodiversity or to sequester carbon. Selected indicators and scoring systems to monitor environmental or climate results are often used, and they will be exactly defined in the contract. You have access to free advice or training when you participate in this contract, and you can voluntarily engage in the monitoring activity.
Collective	You become a **member of a group** of land managers (farmers or foresters) who **applies jointly for compensation in order to implement environmental or climate activities**, e.g., water protection, carbon sequestration, biodiversity or landscape improvement. A minimum number of group members (e.g., 5) from your region is required to **collaborate in order to get a payment**. The group members decide about the implementation and locating the measures, and the distribution of the payment. Within the group, peer land managers and advisors share knowledge and support the achievement of the environmental objectives.
Value chain	As a producer, you are part of the value chain (producer, processor, retailer, distributor). You engage in a contract where you commit to deliver **environmental or climate benefits connected to the production of selected products**, e.g., by carrying out management measures which contribute to water protection, landscape improvement, biodiversity, or carbon sequestration. Often these products get a special label. You are **paid** for it **by the mark**et, mainly through a premium price paid by the processor or retailer.
Land tenure	You enter into a land-tenure contract where you **commit to give particular attention to environmental aspects beyond legal requirements when producing on the leased land**. The landowner accepts a lower **lease payment** than for comparable land under usual land tenure agreements to compensate your additional efforts. In the contract environmentally friendly management practices on the leased land are prescribed in order to maintain or improve environmental targets, e.g., water protection, landscape and biodiversity improvement or carbon sequestration or alternatively.

willingness to enroll in a hypothetical agri-environmental contract/programme, e.g., "self-chosen measures", "better results, higher payment", and "annual compensation". Namely, respondents stated that each one of these characteristics contribute in increasing considerably their willingness to enroll in an environmental contract/

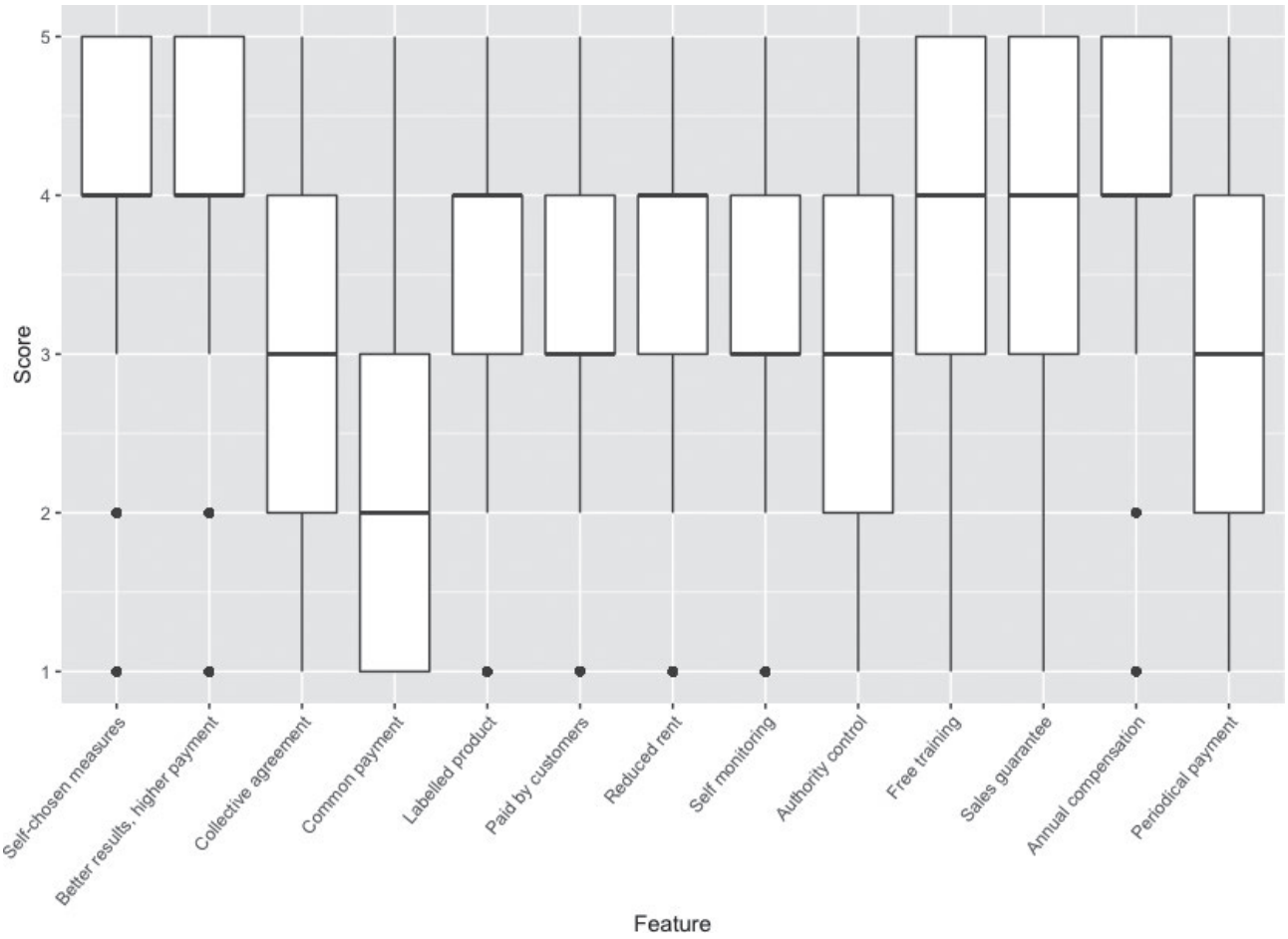

Figure 1. Distribution of the scores of the 13 individual contract features.

programme. In contrast, a feature like, e.g., "common payment" has a negative influence on the willingness to enroll (i.e., it is expected to somewhat decrease such a willingness).

2.3 Methodological approach: proportional odds and partial proportional logit models

The socio-demographic characteristics of the respondents, the characteristics of agricultural holdings, and the scores related to the 13 individual contract features are used as explanatory variables in the models (one for each incentive contract solution) where the ordered response variables are 1) the *easiness of understanding*, 2) the *applicability in the farm*, 3) the *economic benefit*, 4) the *willingness to enroll*.

These outcome variables are ordered categorical variables, based on a Likert scale. They can be treated by the ordered logit model, also called the proportional odds (PO) or parallel lines (PL) model (Mccullagh, 1980; Winship and Mare, 1984). Following the notation of Agresti (2010), let Y be the outcome of interest: an ordinal dependent variable of M categories observed for the i-th individual (i=1,…,N). The generalized ordered logit model can be written as:

$$P(Y_i > j) = g(X\beta_j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1 + \{\exp(\alpha_j + X_i\beta_j)\}}, \quad (1)$$

where j=1,…,M-1. The probabilities that the outcome variable takes on each of the values 1,…,M are equal to:

$$\begin{aligned} &P(Y_i=1)=1-g(X_i\beta_1),\\ &P(Y_i=j)=g(X_i\beta_{j-1})-g(X_i\beta_j), \text{ with } j=2,\ldots,M-1\\ &P(Y_i=M)=g(X_{-i}\beta_{M-1}). \end{aligned} \quad (2)$$

From this generalized framework, special cases can be derived. For example, when M=2, the model in Equation 1) equals the logistic regression, while, for M>2, it

becomes equal to a series of binary logistic regressions, one for each pair of categories of the dependent variable.

The PO/PL model is a further special case that can be written as follows:

$$P(Y_i > j) = g(X\beta) = \frac{\exp(\alpha_j + X_i\beta)}{1 + \{\exp(\alpha_j + X_i\beta)\}}, \quad (3)$$

where j=1,…,M-1. Such a model presents β coefficients that do not vary across the values of j, as it is instead in Equation 1). Therefore, this modelling approach requires that only the α's do vary across the j values and, hence, it implies that the M-1 regression lines are parallel. This is the key underlying assumption of the PO/PL model, usually called "proportionality of the odds". It states that the relationship between each pair of outcome levels is the same. Namely, the shift in individual's preferences from one level of the categorical variable to the higher/lower one is proportional for all the levels of such a variable. It is well-acknowledged that this cannot *always* occur in practice. The method has been largely applied by several disciplines in different fields (Agresti, 2019), but violations of this fundamental assumption which can frequently occur in practice have been nimbly disregarded (Brant, 1990; Long and Freese, 2014; Xu et al., 2022) leading to biased and mis-interpretable results (Agresti, 2010). Furthermore, this assumption has been discovered to be overly restrictive (Williams, 2016).

In fact, the PO/PL model offers two main pros: 1) it can lead to highly interpretable results (Williams, 2016); 2) it benefits from computational efficiency (Agresti, 2010). Although being very sensitive to violations of the proportionality of the odds, by relaxing the assumption, the aforementioned pros can still be of interest in choosing to apply such a modelling strategy. A successful solution for relaxing the assumption is offered by the partial proportional logit model (PPO) or non-parallel lines model (NPL) (Mccullagh and Nelder, 1989; Peterson and Harrell, 1990). This alternative modelling strategy has recently gained attention due to the developments proposed by Williams (2006) and Yee (2010), being a great alternative to the generalized ordered logit model (Williams, 2016).

Relaxing the proportionality of the odds can lead to one or more β's differing across the values of j, while some other coefficients can still be equal. For the sake of clarity, let X_1,X_2,X_3 be three explanatory variables. The model in Equation 3) can be re-written as:

$$P(Y_i > j) = g(X\beta) = \frac{\exp(\alpha_j + X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_{3j})}{1 + \{\exp(\alpha_j + X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_{3j})\}}, \quad (4)$$

where j=1,…,M-1. In the model of Equation 4) the β's for X_1,X_2 are the same for all the values of j, while the coefficient for X_3 can differ.

For the sake of simplicity, the unconstrained PPO model proposed by Peterson and Harrell (1990) and further extended by Lall et al. (2002) is adopted here. This model offers a re-parametrization of the model in Equation 4) such that, for each explanatory variable, we have a coefficient β and M-2 γ coefficients that indicate a deviation from proportionality.

Therefore, here we consider PO/PL models as the starting point of the analysis, test the proportionality of the odds, and (when needed) eventually relax such an assumption by adopting a properly specified PPO/NPL model.

The choice of which explanatory variables should be included in the model for the outcome variable of interest is based on the following stepwise approach. First, we included in the PO-defined model all the potential explanatory variables. Second, we checked for convergence of the model, discarding the explanatory variables that forced convergence to fail. Third, we have undergone the assessment of the parallel lines assumption as suggested by Long and Freese (2014) and Williams (2016): if the whole model fails the assumption according to the Brant test, a PPO-defined model is run, by relaxing the assumption of proportionality of the odds for the explanatory variables for which the Brant test is statistically significant. Fourth, we attempted to discard the explanatory variables showing non-statistically significant coefficients but keeping them if their discarding lowered the log-likelihood and the pseudo-R^2 of the model, in comparison to the other, newly defined model(s) (i.e., we kept them if the model's goodness of fit decreased).

3. RESULTS

In the following, the estimated odds ratios are presented.[6]

The results are depicted according to the prescriptions of Craemer (2009) and Williams (2016): when the explanatory variables included in the model meet the parallel lines assumption, the β coefficients are depicted (with the related p-values). In other words, if the coefficients are depicted only for the first category of the

[6] For the sake of brevity, only the statistically significant explanatory variables are depicted. Please, refer to the supplementary material for the integral version of the results on the models' coefficients. Please, note that we present here only the odds ratios of the statistically significant predictors, although the predictors included in the models were all those depicted in the integral version of the tables in the supplementary material.

ordinal outcome variable (i.e., only in the second column of the tables) this means that the coefficients are the same for all the categories (since the proportionality of the odds does hold), as per the model in Equation 3). When the p-values from the Brant test on proportionality are statistically significant, γ coefficients are depicted (with the related p-values), hence identifying the predictors that are not constrained to meet the parallel lines assumption, as per the model in Equation 4). In such cases, the γ coefficients are shown for each category of the response variable (i.e., in the other columns of the tables).

3.1 Result-based contracts

Table 4 depicts the odds ratio from the models for the RB contract. They are PO/PL models, as per the one depicted in Equation 3).

In terms of odds, it is worth noticing that for members of nature conservation/environmental organizations, the odds of being more likely to easily understand the RB contracts are almost 2 times greater. By a unit increase in the scoring of *self-chosen measures*, the odds of being more likely to easily understand the contract is 1.8 times greater.

Table 4. Odds ratio, result-based contract solution.

Explanatory variable	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
		Easiness of understanding		
Age (18-30)				
31-40	0.922 (0.859)			
41-50	‡ **0.395** (0.030)			
51-60	0.540 (0.141)			
61-70	0.620 (0.312)			
>71	0.699 (0.529)			
Membership (none)				
farmers union	1.361 (0.191)			
nature conservation/ environmental org.	‡ **1.995** (0.046)			
Self-chosen measures	‡ **1.755** (0.016)			
		Applicability in the farm		
Proportion of holding sales – to cooperatives (0%)				
1-30 %	1.984 (0.116)			
31-60 %	1.616 (0.340)			
61-100 %	‡ **2.266** (0.006)			
Organic production (no)				
yes	‡ **2.301** (0.002)			
Self-chosen measures	‡ **1.687** (0.038)			
Collective agreement	‡ **1.627** (0.004)			
Reduced land rent	‡ **1.917** (0.006)			
		Economic benefit		
Better results, higher payment	‡ **1.731** (0.036)			
		Willingness to enroll		
Age (18-30)				
31-40	1.345 (0.598)			
41-50	0.909 (0.850)			
51-60	0.664 (0.408)			
61-70	0.646 (0.428)			
>71	‡ **0.199** (0.016)			
Self-monitoring	‡ **1.659** (0.035)			
Free training	‡ **0.494** (0.029)			
Periodical payment	‡ **1.691** (0.012)			

Note: The reference modality of the explanatory variable is in parentheses. * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ in bold indicates the 0.05 level of statistical significance.

For the holdings that are largely exposed to cooperatives in terms of sales, the odds of considering "applicable" the RB contract solution is 2.3 times greater. For the holdings producing organic, the odds of being more likely to perceive "applicable" the RB contracts is 2.3 times greater than non-organic holdings. For the higher scoring of *self-chosen measures*, *collective agreement,* and *reduced rent land*, the odds of the perceived applicability in the farm are between 1.6 and 1.9 times greater.

For farmers giving higher scores to the possibility that, within the contract, the payment gets higher as much as the achieved environmental results ameliorate, the odds of perceiving as "economic beneficial" the RB contract is 1.7 times greater.

With a unit increase in the scoring of *free training,* the odds of being more likely to enroll in RB contracts decrease, while by a unit increase in the scoring of *self-monitoring* and *periodical payment*, the odds of being willing to enroll in RB contracts are 1.7 times greater.

3.2 Collective contracts

Table 5 depicts the odds ratio from the models for the Co contract. The models for the outcome variables *easiness of understanding* and *economic benefit* are PPO/NPL models, as per the one depicted in Equation 4). The other two models for the outcome variables *applicability in the farm* and *willingness to enroll* are PO/PL models, as per the one in Equation 3).

The odds ratio of *direct CAP payments* suggests that for the holdings receiving this payment, the odds

Table 5. Odds ratio, collective contract solution.

Explanatory variable	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
		Easiness of understanding		
Direct CAP payments (no)				
yes	0.360 (0.050)	1.749 (0.236)	‡ **5.436** (0.005)	‡ **10.134** (0.046)
Previous experience (no)				
yes	‡ **6.189** (0.000)			
Collective agreement	‡ **2.104** (0.022)	0.724 (0.236)	0.705 (0.288)	‡ **0.441** (0.023)
		Applicability in the farm		
Age (18-30)				
31-40	‡ **0.388** (0.040)			
41-50	‡ **0.357** (0.014)			
51-60	0.491 (0.075)			
61-70	0.748 (0.521)			
>71	‡ **0.328** (0.037)			
Utilized Agricultural Area owned – in hectares	‡ **0.827** (0.024)			
Collective agreement	‡ **1.898** (0.001)			
Common payment	‡ **1.604** (0.006)			
		Economic benefit		
Annual compensation	‡ **1.476** (0.038)			
		Willingness to enroll		
Age (18-30)				
31-40	0.448 (0.117)			
41-50	‡ **0.318** (0.016)			
51-60	0.443 (0.075)			
61-70	0.552 (0.251)			
>71	‡ **0.181** (0.006)			
Collective agreement	‡ **1.527** (0.039)			
Common payment	‡ **1.666** (0.007)			
Self-monitoring	‡ **1.996** (0.003)			

Note: The reference modality of the explanatory variable is in parentheses. * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ in bold indicates the 0.05 level of statistical significance.

of being "Likely" or "Very Likely" versus the lower categories of *easiness of understanding*, as well as the odds of being "Very Likely" (versus the lower categories) are, respectively, 5.4 and 10 times greater than that of the holdings not receiving the payment. Having previously experienced collective-alike measures makes the odds of being more likely to easily understand the Co contract 6.2 times greater. *Collective agreement* produces asymmetric effects on the *easiness of understanding*: by a unit increase in the scoring of such contract feature, the odds of being more likely to consider "easy to understand" the Co contract is greater, when "Very Unlikely" is confronted with the upper categories. Nevertheless, the odds ratio for the highest level of the response variable ("Very Likely" versus the lower categories) decreases.

By a unit increase in the scoring of the *collective agreement*, the odds of being more likely to perceive "applicable in the farm" the Co contract solution is 1.9 times greater. By a unit increase in the scoring of the contract feature *common payment*, the odds of being more likely to consider the Co contract applicable is 1.6 times greater.

For an increase in the scoring of *annual compensation* the odds of perceiving as "economic beneficial" the Co contract solution is 1.5 times greater.

For an increase in the scoring of the predictors *collective agreement*, *common payment*, and *self-monitoring* the odds of being more likely to enroll in Co contracts are between 1.5 and 2 times greater.

3.3 Value chain contracts

Table 6 depicts the odds ratio from the models for the VC contract. All models are PO/PL models, as per the one in Equation 3).

For the holdings selling to private direct consumers a share between 1% and 60% of the holding product(s), the odds of being more likely to consider "easily understandable" the VC contracts is 2 up to 3.6 times greater. For livestock holdings, the odds of being more likely to perceive "easy to understand" the VC contract is 2.8 greater than that of permanent-specialized farms. By a unit increase of the hectares of UAA rented-in by the holding, the odds of being more likely to consider "understandable" the VC contract solution increases very slightly (it is 1.003 times greater). For respondents who experienced similar measures, the odds of being more likely to "easily understand" the VC contract is almost 8 times greater.

Concerning the *applicability in the farm*, the previous experience boosts the odds (for "experienced" respondents the odds ratio is 4.3 times greater).

The (potential) economic benefit of VC contracts is negatively influenced by *age*, while considering the *willingness to enroll*, for livestock holdings the odds of being more likely to enroll is 3.2 times greater than that of farms specialized in permanent crops. In addition, the previous experience relevantly boosts the odds ratio, while for higher scoring of *paid by customers* and *control by authority*, the odds of being more likely to enroll are 1.6 times greater and 1.7 times greater, respectively.

3.4 Land tenure contracts

Table 7 depicts the odds ratio from the models for the LT contract. The model for the outcome variable *economic benefit* is a PPO/NPL model – depicted in Equation 4) –, while the others are, all, PO/PL models, as per the one depicted in Equation 3).

In terms of odds ratio, for those who have previously experienced land tenure-alike measures, the odds of being more likely to consider "understandable" the land tenure contract solution is 5.8 greater. By a unit increase in the scoring of *self-chosen measures*, the odds of being more likely to easily understand the LT contracts is 1.8 times greater.

The older the respondent, the lower the odds of perceiving "applicable" the LT contracts, while for an increase in the scoring of *control by authority* the odds of being more likely to consider "applicable" the LT contract is 1.4 times greater.

Economic benefit is influenced by the holding exposure to direct consumers (in terms of the amount of sales). Asymmetric effects are generated by the increase in the scoring of *self-chosen measures*, hinting at lower odds of being more likely to consider "economically beneficial" the LT contract. For higher scoring of *reduced land rent*, the odds of being more likely to perceive the "economic beneficial" of the LT contract is 1.9 times greater. *Control by authority* has also a positive impact on the odds of being more likely to consider "beneficial" the LT contract. By a unit increase in the scoring of *sales guarantee*, the odds of being more likely to perceive "economically beneficial" the LT contract decreases.

Willingness to enroll is negatively influenced by *age*, but it is strongly and positively impacted by the exposure of the holding towards the sales to processors and private wholesalers/retailers, as well as by the increase in the scoring of *reduced land rent* (odds ratio is 2.3 times greater).

Table 6. Odds ratio, value chain contract solution.

Explanatory variable	VU vs U, N, L, VL* VU, U vs N, L, VL* VU, U, N vs L, VL* VU, U, N, L vs VL*
Easiness of understanding	
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	‡ **0.285** (0.000)
31-60 %	0.505 (0.150)
61-100 %	1.176 (0.659)
Proportion of holding's sales – direct to final consumer (0%)	
1-30 %	‡ **2.412** (0.019)
31-60 %	‡ **3.602** (0.025)
61-100 %	0.528 (0.126)
Specialization (arable)	
horticulture	1.100 (0.867)
permanent	1.122 (0.711)
livestock	‡ **2.773** (0.016)
mixed	1.108 (0.781)
Utilized Agricultural Area rented in – in hectares	‡ **1.003** (0.046)
Previous experience (no)	
yes	‡ **7.963** (0.000)
Applicability in the farm	
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	‡ **0.462** (0.034)
31-60 %	1.034 (0.948)
61-100 %	1.023 (0.951)
Proportion of holding sales – direct to final consumer (0%)	
1-30 %	‡ **2.326** (0.033)
31-60 %	0.699 (0.956)
61-100 %	0.636 (0.284)
Previous experience (no)	
yes	‡ **4.311** (0.001)
Labelled product	‡ **2.318** (0.001)
Control by authority	‡ **1.538** (0.038)
Economic benefit	
Age (18-30)	
31-40	0.762 (0.534)
41-50	0.652 (0.285)
51-60	‡ **0.442** (0.032)
61-70	0.551 (0.183)
>71	0.766 (0.613)
Willingness to enroll	
Specialization (arable)	
horticulture	1.468 (0.660)
permanent	0.951 (0.893)
livestock	‡ **3.225** (0.050)
mixed	0.864 (0.754)
Previous experience (no)	
yes	‡ **15.748** (0.001)
Paid by customers	‡ **1.589** (0.043)
Control by authority	‡ **1.651** (0.033)

Note: The reference modality of the explanatory variable is in parentheses. * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ in bold indicates the 0.05 level of statistical significance.

Table 7. Odds ratio, land tenure contract solution.

Explanatory variable	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
	Easiness of understanding			
Age (18-30)				
31-40	0.421 (0.080)			
41-50	‡ **0.361** (0.026)			
51-60	‡ **0.383** (0.030)			
61-70	‡ **0.318** (0.024)			
>71	0.436 (0.156)			
Previous experience (no)				
yes	‡ **5.754** (0.000)			
Self-chosen measures	‡ **1.833** (0.019)			
Sales guarantee	‡ **0.560** (0.043)			
	Applicability in the farm			
Age (18-30)				
31-40	-0.493 (0.113)			
41-50	-0.505 (0.085)			
51-60	-0.572 (0.136)			
61-70	‡ **0.381** (0.027)			
>71	‡ **0.359** (0.041)			
Control by authority	‡ **1.357** (0.047)			
	Economic benefit			
Proportion of holding sales – direct to final consumer (0%)				
1-30 %	1.561 (0.235)			
31-60 %	‡ **3.459** (0.040)			
61-100 %	0.907 (0.818)			
Self-chosen measures	2.701 (0.053)	‡ **0.357** (0.019)	0.533 (0.224)	0.397 (0.105)
Reduced land rent	‡ **1.924** (0.004)			
Control by authority	‡ **1.616** (0.013)			
Sales guarantee	‡ **0.535** (0.029)			
	Willingness to enroll			
Age (18-30)				
31-40	0.442 (0.163)			
41-50	0.411 (0.095)			
51-60	0.383 (0.065)			
61-70	‡ **0.235** (0.012)			
>71	‡ **0.190** (0.011)			
Proportion of holding sales – to processor (0%)				
1-30 %	‡ **3.348** (0.005)			
31-60 %	0.058 (0.922)			
61-100 %	-0.169 (0.680)			
Proportion of holding sales – to private wholesaler/retailer (0%)				
1-30 %	0.486 (0.065)			
31-60 %	‡ **0.350** (0.036)			
61-100 %	0.830 (0.650)			
Reduced land rent	‡ **2.334** (0.001)			

Note: The reference modality of the explanatory variable is in parentheses. * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ in bold indicates the 0.05 level of statistical significance.

4. DISCUSSION

The results suggest different patterns behind the farmers' perceptions in terms of understandability, applicability, economic benefit, and willingness to enroll related to the four incentive contract solutions investigated.

The respondent's age often plays a key role in determining the overall "acceptability" of the innovative contract solutions, as it is highlighted, e.g., by Šumrada et al. (2022) for the result-based schemes in Slovenia. We find empirical evidence that being older hints at lower levels of the overall "acceptability" of innovative contract solutions. Older farmers often also show a limited willingness to enroll.

In line with the research findings of the literature on the subject (see, e.g., Gailhard et al., 2015; Westerink et al., 2017) we find that the previous experience of similar and/or specific "contract solution-alike" measures has a very strong say in determining the preferences of the farmers/land managers. This is straightforward, for example, in terms of the more solid perception of the easiness of understanding related to both the collective and value chain contracts.

Some structural characteristics of the holdings play a peculiar role in influencing the respondents' perceptions, as it is suggested by Gailhard and Bojnec (2015) and Russi et al. (2016). Considering the VC contract solution this is particularly evident. Indeed, both the holding exposure to certain channels of trade and the amount of sales are relevant boosts of the perceived easiness of understanding and applicability in the farm. In the case of RB contracts, producing organic positively influences the perceived applicability in the farm of such contracts, differently from Šumrada et al. (2021) which found no evidence of the holdings' structural characteristics in influencing the adoption of result-based schemes in Slovenia. We find also that the perception about the applicability of Co contracts is negatively influenced by the size of the farm, in line with the findings of Gailhard et al. (2015) on the agri-environmental measures, while, even if limited to RB contracts, other findings show a non-significant influence of the farm's size in the adoption of potential payment-by-result measures (Birge et al., 2017).

5. CONCLUSIONS

We investigated four novel contract solutions that are expected to target more efficiently and effectively the provision of agri-environmental-climate public goods. Namely, the result-based (RB), collective (Co), value chain (VC), and land tenure (LT) contracts. These contract types have been analyzed in terms of farmers' acceptability and willingness to uptake, by assessing i) farmers' perception of the easiness of understanding related to the innovative contract solution; ii) farmers' perception of the contract's applicability in the farm; iii) farmers' perception of the economic benefit deriving from the contract; iv) farmers' willingness to enroll.

The main policy implications concern the fact that farmers show to be rather open toward the contract solutions investigated. At the same time, different farmer's/farm characteristics may affect acceptance of different contract solutions and this requires careful consideration in the choice of the policy measures and their policy design.

By summarizing the main results, with no intention of "profiling" the potential "contractor" of such incentive contract solutions, we can highlight that the general preference of farmers is driven by the following aspects:

- RB contracts, the most well-acknowledged instrument, are largely appreciated by the agricultural holdings that produce organic, as well as by farmers being members of nature conservation/environmental organizations. These two aspects act as relevant leverage of the understanding and the perceived applicability of such contract solution (potentially, also as a boost for the perceived importance of the result-based instruments).
- Co contracts are particularly opposed by big farms which tend to consider them as unapplicable in their agricultural context. In contrast, those receiving direct CAP payments tend to be more inclined toward the adoption of such a type of contract.
- The most innovative contact solutions (in terms of diffusion and knowledge from the point of view of "contractors"), like VC and LT contracts, are largely influenced by the previous experience of the contractor with respect to "contract solution-alike" measures. Being absent such an experience (or perception of experience), VC and LT contract solutions appear to be far more complicated to understand and non-trustworthy.
- VC contracts seem to be attractive, above all, for those agricultural holdings that are already exposed to the value chains of the supply system, e.g., in terms of sales to wholesalers/retailers and/or direct consumers. These farms are positively impacted in terms of understandability and applicability related to such contract solutions. In addition, farms that tend to have a more solid tradition in value chains, such as livestock specialized holdings, are far more interested in VC contracts.

– Across the four contract solutions, age has a peculiar (but well-acknowledged in the literature on the subject) role: the older the farmer, the lower the willingness to consider the new contract solution as applicable.

The acceptance of contract types is also affected by the perception of individual contract features. As expected, the perceptions of the contractual elements that more evidently characterize each contract solution influence more relevantly the acceptance of farmers about the incentive contract type (e.g., the collective agreement for Co contracts or the reduced land rent for LT contracts). However, there are additional contract features that can play a role in impacting the level of acceptance. For example, with respect to RB contracts, a positive perception of the possibility of freely deciding about the management practices to achieve the specified environmental result(s) can increase the perceived understandability of the contract.

Overall, our findings hint at the fact that improved contract solutions can be based on a mix of instruments and that these can be more profitably implemented when tailored to the need of farmers/land managers through a flexible combination of a larger set of different contractual elements contributing to the contract design.

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SUPPLEMENTARY MATERIAL

Tables 4, 5, 6, and 7 of the manuscript depict the odds ratio of the statistically significant explanatory variables included in the models considered.

Here, we present the same tables which, instead, do depict the coefficients of the explanatory variables (same referring models). However, the following tables are presented in their integral version (i.e., the following tables depict the estimated models' coefficients concerning all the explanatory variables that were included in the models, not only the statistically significant ones).

Each table is followed by a brief comment about the statistically significant coefficients.

The four models in Table 4 are PO/PL models, as per the one depicted in Equation 3) of the manuscript.

All the statistically significant variables depicted in Table 4 meet the proportionality of the odds assumption. Higher values of *age* make it more likely that the respondent will be in the current (or lower) category of *easiness of understanding*. Being a member of nature conservation/environmental organizations makes it more likely that the respondent will understand the contract more easily. An increase in scoring of *self-chosen measures* makes it more likely that the respondent will be in a higher category of *easiness of understanding*.

The coefficients of the *proportion of holding sales (to cooperatives)*, *organic production*, *self-chosen measures*, and *collective agreement* positively influence the perceived applicability of RB contracts.

Better results, higher payment is the only statistically significant predictor for *economic benefit* in relation to RB contracts. An increase in the scoring of this contract characteristic makes it more likely that the respondent will be in a higher category of *economic benefit*.

Being older makes it more likely that the respondent will be at the current level (or lower) of the willingness to enroll in the contract. Increases in scoring of *self-monitoring* and *periodical payment* make it more likely that the respondent will be in a higher category of *willingness to enroll*. An increase in the scoring of the contract feature free training makes it more likely that the respondent will be in the current (or lower) level of willingness.

The models in Table 5 related to the outcome variables *easiness of understanding* and *economic benefit* are PPO/NPL models, as per the one depicted in Equation 4) of the manuscript. In contrast, the models for the outcome variables *applicability in the farm* and *willingness to enroll* are PO/PL models, as per the one depicted in Equation 3) of the manuscript.

Direct CAP payments and *collective agreement* predictors do fail the test on the proportionality of the odds. Receiving direct CAP payments boosts the understandability of the collective contract solution, above all with respect to the extreme upper levels of the ordinal outcome variable. *Collective agreement* produces divergent effects on the extreme lower and upper categories. *Previous experience* suggests that having experienced collective-alike measures makes the collective contract more "easily understandable".

Being older negatively influences the perceived applicability of Co contracts. Being bigger in terms of holding size makes it more likely that the respondent will perceive "applicable" the Co contract. An increase in the scoring of the variables *collective agreement* and *common payment* makes it more likely that the respondent will perceive "applicable" the Co contract.

Periodical payment is the only statistically significant predictor influencing (negatively) the *economic benefit* of Co contracts.

The willingness to enroll is influenced by *age*, *collective agreement*, *common payment*, and *self-monitoring*. Being older makes it more likely that the respondent will be in the current (or lower) category of *willingness to enroll*, while the increase in the scoring of the three contract features has a positive effect.

The models in Table 6 are, all, PO/PL models, as per the one depicted in Equation 3) of the manuscript.

Being a holding with a share of sales of 1-30% to private wholesalers/retailers makes it less likely that a respondent will be in a higher category of *easiness of understanding*. Higher values of *proportion to holding sales (direct to final consumer)* make it more likely that the respondent will be in a higher category (than the current one) of the perceived understandability. Being livestock-specialized holding makes it more likely that the VC contracts are more "easily understandable". The increase in the amount of rented-in land (in terms of hectares of UAA) makes it more likely that the respondent will easily understand the VC contract, as well as having experienced value chain-alike measures.

Being a holding with a share of sales of 1-30% to private wholesalers/retailers (compared to holdings not exposed to such trades) makes it less likely that the respondent will be in a higher level of *applicability in the farm*. Being a holding exposed for the same share to sales to direct consumers makes it more likely that the respondent will be in a higher category of the applicability of VC contracts. Having experienced value chain-alike measures makes it more likely that the respondent will perceive "applicable" the VC contract. Higher scoring of *labelled product* and *control by authority* make it more likely that the respondent will be in a higher category of *applicability in the farm*.

Table 4. Model for result-based contract solution.

Explanatory variable	VU vs U, N, L, VL* VU, U vs N, L, VL* VU, U, N vs L, VL* VU, U, N, L vs VL*
	Easiness of understanding
Age (18-30)	
31-40	-0.081 (0.859)
41-50	ǂ **-0.929** (0.030)
51-60	-0.616 (0.141)
61-70	-0.478 (0.312)
>71	-0.358 (0.529)
Educational level (primary)	
secondary	0.072 (0.798)
university or higher	0.507 (0.118)
Membership (none)	
farmers union	0.308 (0.191)
nature conservation/ environmental org.	ǂ **0.691** (0.046)
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	-0.305 (0.326)
31-60 %	-0.276 (0.531)
61-100 %	-0.158 (0.573)
Self-chosen measures	ǂ **0.562** (0.016)
Better results, higher payment	0.232 (0.346)
Collective agreement	0.280 (0.079)
Labelled product	0.097 (0.651)
	Applicability in the farm
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	-0.329 (0.299)
31-60 %	0.363 (0.457)
61-100 %	-0.136 (0.661)
Proportion of holding sales – to cooperatives (0%)	
1-30 %	0.685 (0.116)
31-60 %	0.480 (0.340)
61-100 %	ǂ **0.818** (0.006)
Organic production (no)	
yes	ǂ **0.833** (0.002)
Self-chosen measures	ǂ **0.530** (0.038)
Better results, higher payment	0.404 (0.133)
Collective agreement	ǂ **0.487** (0.004)
Labelled product	0.236 (0.299)
Reduced land rent	ǂ **0.651** (0.006)
Self-monitoring	0.184 (0.368)
Control by authority	0.195 (0.299)
Free training	-0.267 (0.355)
Sales guarantee	-0.335 (0.257)
Annual compensation	0.441 (0.172)
Periodical payment	0.271 (0.147)
	Economic benefit
Self-chosen measures	0.440 (0.082)
Better results, higher payment	ǂ **0.549** (0.036)

(Continued)

Table 4. (Continued).

Explanatory variable	VU vs U, N, L, VL* VU, U vs N, L, VL* VU, U, N vs L, VL* VU, U, N, L vs VL*
Collective agreement	0.163 (0.304)
Labelled product	-0.132 (0.557)
Reduced land rent	0.027 (0.901)
Self-monitoring	0.332 (0.103)
Control by authority	-0.177 (0.069)
Free training	-0.068 (0.540)
Sales guarantee	-0.309 (0.805)
Annual compensation	0.320 (0.335)
Periodical payment	0.091 (0.623)
	Willingness to enroll
Age (18-30)	
31-40	0.297 (0.598)
41-50	-0.096 (0.850)
51-60	-0.410 (0.408)
61-70	-0.437 (0.428)
>71	‡ **-1.612** (0.016)
Educational level (primary)	
secondary	-0.217 (0.521)
university or higher	0.236 (0.547)
Membership (none)	
farmers union	-0.290 (0.280)
nature conservation/environmental org.	0.546 (0.242)
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	0.418 (0.252)
31-60 %	-0.077 (0.874)
61-100 %	0.193 (0.610)
Previous experience (no)	
yes	0.041 (0.924)
Self-chosen measures	0.246 (0.370)
Better results, higher payment	0.322 (0.277)
Collective agreement	0.271 (0.180)
Labelled product	0.310 (0.213)
Reduced land rent	0.142 (0.563)
Self-monitoring	‡ **0.506** (0.035)
Control by authority	-0.055 (0.802)
Free training	‡ **-0.705** (0.029)
Sales guarantee	0.371 (0.228)
Annual compensation	0.063 (0.862)
Periodical payment	‡ **0.525** (0.012)

Note: The reference modality of the explanatory variable is in parentheses. * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ in bold indicates the 0.05 level of statistical significance.

Age produces a negative effect on *economic benefit*.

Being specialized in livestock makes it more likely that the respondent will be in a higher level of the willingness to enroll in VC contracts. Having experienced value chain-alike measures makes it more likely that the respondent will be in the current (or lower) category of *willingness to enroll*. An increase in the scoring of *paid by customers* and *control by authority* has a positive impact on *willingness to enroll*.

The models in Table 7 are, all but the one for the

Table 5. Model for collective contract solution.

Explanatory variable	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
	Easiness of understanding			
Membership (none)				
farmers union	-0.085 (0.841)			
nature conservation/ environmental org.	0.735 (0.496)			
Specialization (arable)				
horticulture	0.107 (0.835)			
permanent	-0.228 (0.440)			
livestock	0.184 (0.638)			
mixed	-0.014 (0.971)			
Organic production (no)				
yes	-0.176 (0.505)			
Direct CAP payments (no)				
yes	-1.022 (0.051)	0.559 (0.236)	‡ **1.693** (0.005)	‡ **2.316** (0.046)
Previous experience (no)				
yes	‡ **1.823** (0.000)			
Self-chosen measures	-0.100 (0.693)			
Better results, higher payment	0.088 (0.744)			
Collective agreement	‡ **0.744** (0.022)	-0.323 (0.236)	-0.350 (0.288)	‡ **-0.818** (0.023)
Labelled product	0.072 (0.751)			
Paid by customers	0.088 (0.646)			
Reduced land rent	0.321 (0.140)			
Self-monitoring	0.255 (0.223)			
Control by authority	-0.069 (0.715)			
Free training	-0.035 (0.900)			
Sales guarantee	-0.038 (0.891)			
Annual compensation	0.257 (0.432)			
Periodical payment	0.254 (0.174)			
	Applicability in the farm			
Age (18-30)				
31-40	‡ **-0.946** (0.040)			
41-50	‡ **-1.029** (0.014)			
51-60	-0.711 (0.075)			
61-70	-0.291 (0.521)			
>71	‡ **-1.116** (0.037)			
Proportion of holding sales – to private wholesaler/retailer (0%)				
1-30 %	-0.190 (0.533)			
31-60 %	0.658 (0.125)			
61-100 %	-0.134 (0.629)			
Utilized Agricultural Area owned – in hectares	‡ **-0.001** (0.024)			
Self-chosen measures	0.220 (0.375)			
Better results, higher payment	-0.004 (0.989)			
Collective agreement	‡ **0.641** (0.001)			
Common payment	‡ **0.472** (0.006)			
Reduced land rent	0.352 (0.105)			
Self-monitoring	0.281 (0.153)			
Control by authority	-0.107 (0.556)			

(Continued)

Table 5. (Continued).

Explanatory variable	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Free training	0.087 (0.754)			
Sales guarantee	-0.191 (0.461)			
Annual compensation	0.109 (0.718)			
Periodical payment	0.274 (0.130)			
	Economic benefit			
Age (18-30)				
31-40	-0.588 (0.208)			
41-50	-0.368 (0.394)			
51-60	-0.386 (0.353)			
61-70	-0.077 (0.871)			
>71	-0.758 (0.168)			
Membership (none)				
farmers union	-0.323 (0.186)			
nature conservation/ environmental org.	0.209 (0.575)			
Proportion of holding sales – to processor (0%)				
1-30 %	0.389 (0.253)			
31-60 %	-0.240 (0.657)			
61-100 %	-0.456 (0.244)			
Proportion of holding sales – to private wholesaler/retailer (0%)				
1-30 %	-0.160 (0.633)			
31-60 %	0.474 (0.324)			
61-100 %	-0.268 (0.507)			
Proportion of holding sales – to cooperatives (0%)				
1-30 %	-0.227 (0.618)			
31-60 %	-0.885 (0.071)			
61-100 %	-0.592 (0.075)			
Previous experience (no)				
yes	0.373 (0.335)			
Self-chosen measures	0.127 (0.617)			
Better results, higher payment	0.151 (0.561)			
Collective agreement	0.140 (0.587)	0.301 (0.108)	0.229 (0.395)	0.453 (0.232)
Common payment	0.305 (0.085)			
Labelled product	-0.239 (0.314)			
Paid by customers	0.039 (0.847)			
Reduced land rent	0.391 (0.077)			
Self-monitoring	0.361 (0.094)			
Control by authority	0.192 (0.321)			
Free training	-0.088 (0.760)			
Sales guarantee	0.003 (0.990)			
Annual compensation	-0.060 (0.843)			
Periodical payment	‡ **0.389** (0.038)			
	Willingness to enroll			
Age (18-30)				
31-40	-0.802 (0.117)			
41-50	‡ **-1.146** (0.016)			
51-60	-0.813 (0.075)			
61-70	-0.595 (0.251)			
>71	‡ **-1.711** (0.006)			

(Continued)

Table 5. (Continued).

Explanatory variable	VU vs U, N, L, VL* VU, U vs N, L, VL* VU, U, N vs L, VL* VU, U, N, L vs VL*
Membership (none)	
farmers union	-0.406 (0.123)
nature conservation/ environmental org.	0.033 (0.937)
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	0.095 (0.785)
31-60 %	-0.137 (0.771)
61-100 %	-0.132 (0.709)
Direct CAP payments (no)	
yes	-0.264 (0.398)
Previous experience (no)	
yes	0.286 (0.492)
Self-chosen measures	0.426 (0.117)
Better results, higher payment	-0.257 (0.366)
Collective agreement	‡ **0.423** (0.039)
Common payment	‡ **0.510** (0.007)
Labelled product	-0.385 (0.126)
Paid by customers	0.261 (0.212)
Reduced land rent	0.428 (0.070)
Self-monitoring	‡ **0.691** (0.003)
Control by authority	0.139 (0.488)
Free training	0.267 (0.374)
Sales guarantee	-0.477 (0.107)
Annual compensation	0.192 (0.583)
Periodical payment	0.325 (0.092)

Note: The reference modality of the explanatory variable is in parentheses. * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ in bold indicates the 0.05 level of statistical significance.

outcome variable *economic benefit* that is a PPO/NPL model (as the one in Equation 4) of the manuscript), PO/PL models, as per the one depicted in Equation 3) of the manuscript.

In Table 7, the predictor *self-chosen measures* fails to meet the assumption of proportionality of the odds. Being older makes it more likely that the respondent will be in the current (or lower) category of *easiness of understanding*. Having previously experienced land tenure-alike measures makes it more likely that the respondent will be in a higher category of *easiness of understanding*. An increase in scoring of *self-chosen measures* makes it more likely that the respondent will be in a higher level of *easiness of understanding*, while an increase in scoring of *sales guarantee* makes it more likely that the respondent will be in the current (or lower) category.

Being older makes it more likely that the respondent will be in the current (or lower) category of *applicability in the farm*. Higher values of *control by authority* makes it more likely that the respondent will consider "applicable" the LT contracts.

Being a holding with a share of 31-60% of sales directly to final consumers makes it more likely that the respondent will be in a higher category of the perceived applicability of LT contracts. An increase in scoring of *reduced land rent* makes it more likely that the respondent will be in a higher category of the ordinal outcome variable. An increase in scoring of *control by authority* makes it more likely that the respondent will perceive "applicable" the LT contract solution. A negative impact on the perceived economic benefit of LT contracts is generated by the increase in the scoring of *sales guarantee*.

Being older makes it more likely that the respondent will be in the current (or lower) category of *willingness to enroll*. Being a holding with a share of sales of 1-30% to processors (compared to holdings not exposed to such trades) makes it more likely that the respondent will be in a higher category of *willingness to enroll*. Being exposed to the sales to private wholesalers/retailers for a share of 31-60% makes it more likely that the respondent will be in the current (or lower) level of willingness, while it is positively impacted by *reduced land rent*.

Table 6. Model for value chain contract solution.

Explanatory variable	VU vs U, N, L, VL* VU, U vs N, L, VL* VU, U, N vs L, VL* VU, U, N, L vs VL*
	Easiness of understanding
Membership (none)	
farmers union	0.276 (0.270)
nature conservation/ environmental org.	0.230 (0.551)
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	‡ **-1.255** (0.000)
31-60 %	-0.683 (0.150)
61-100 %	0.162 (0.659)
Proportion of holding sales – direct to final consumer (0%)	
1-30 %	‡ **0.881** (0.019)
31-60 %	‡ **1.281** (0.025)
61-100 %	-0.640 (0.126)
Specialization (arable)	
horticulture	0.096 (0.867)
permanent	0.115 (0.711)
livestock	‡ **1.020** (0.016)
mixed	0.102 (0.781)
Utilized Agricultural Area rented in – in hectares	‡ **0.003** (0.046)
Direct CAP payments (no)	
yes	-0.171 (0.556)
Previous experience (no)	
yes	‡ **2.075** (0.000)
Self-chosen measures	0.022 (0.931)
Better results, higher payment	-0.171 (0.526)
Labelled product	-0.126 (0.606)
Paid by customers	0.164 (0.422)
Reduced land rent	0.289 (0.208)
Self-monitoring	0.343 (0.112)
Control by authority	0.146 (0.471)
Free training	-0.036 (0.898)
Sales guarantee	-0.005 (0.984)
Annual compensation	0.328 (0.304)
Periodical payment	0.121 (0.526)
	Applicability in the farm
Age (18-30)	
31-40	-0.048 (0.926)
41-50	-0.553 (0.247)
51-60	-0.580 (0.201)
61-70	-0.348 (0.508)
>71	-0.628 (0.294)
Membership (none)	
farmers union	-0.023 (0.930)
nature conservation/ environmental org.	0.108 (0.792)
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	‡ **-0.773** (0.034)
31-60 %	0.337 (0.948)
61-100 %	0.023 (0.951)

(Continued)

Table 6. (Continued).

Explanatory variable	VU vs U, N, L, VL* VU, U vs N, L, VL* VU, U, N vs L, VL* VU, U, N, L vs VL*
Proportion of holding sales – direct to final consumer (0%)	
1-30 %	‡ **0.844** (0.033)
31-60 %	-0.032 (0.956)
61-100 %	-0.453 (0.284)
Specialization (arable)	
horticulture	-0.201 (0.727)
permanent	-0.208 (0.509)
livestock	0.614 (0.159)
mixed	-0.628 (0.108)
Utilized Agricultural Area rented in – in hectares	0.003 (0.090)
Direct CAP payments (no)	
yes	0.071 (0.816)
Previous experience (no)	
yes	‡ **1.461** (0.001)
Self-chosen measures	-0.083 (0.754)
Better results, higher payment	0.071 (0.788)
Labelled product	‡ **0.841** (0.001)
Paid by customers	-0.265 (0.209)
Reduced land rent	0.085 (0.726)
Self-monitoring	0.195 (0.381)
Control by authority	‡ **0.430** (0.038)
Free training	0.221 (0.438)
Sales guarantee	0.093 (0.748)
Annual compensation	0.299 (0.362)
Periodical payment	0.055 (0.783)
	Economic benefit
Age (18-30)	
31-40	-0.272 (0.534)
41-50	-0.482 (0.285)
51-60	‡ **-0.817** (0.032)
61-70	-0.596 (0.183)
>71	-0.267 (0.613)
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	-0.366 (0.262)
31-60 %	0.538 (0.231)
61-100 %	0.270 (0.418)
Proportion of holding sales – direct to final consumer (0%)	
1-30 %	0.531 (0.145)
31-60 %	-0.035 (0.948)
61-100 %	-0.640 (0.121)
Previous experience (no)	
yes	-0.260 (0.451)
Self-chosen measures	-0.156 (0.524)
Better results, higher payment	0.195 (0.429)
Labelled product	0.323 (0.181)
Reduced land rent	0.162 (0.458)
Self-monitoring	0.279 (0.195)
Control by authority	0.269 (0.144)

(Continued)

Table 6. (Continued).

Explanatory variable	VU vs U, N, L, VL* VU, U vs N, L, VL* VU, U, N vs L, VL* VU, U, N, L vs VL*
Free training	-0.135 (0.618)
Sales guarantee	0.135 (0.619)
Annual compensation	0.309 (0.285)
	Willingness to enroll
Age (18-30)	
31-40	-0.973 (0.187)
41-50	-0.731 (0.300)
51-60	-0.764 (0.255)
61-70	-0.544 (0.461)
>71	-1.048 (0.198)
Membership (none)	
farmers union	-0.247 (0.437)
nature conservation/ environmental org.	1.200 (0.188)
Proportion of holding sales – to private wholesaler/retailer (0%)	
1-30 %	-0.721 (0.113)
31-60 %	-0.673 (0.311)
61-100 %	0.133 (0.837)
Proportion of holding sales – to cooperatives (0%)	
1-30 %	-0.707 (0.177)
31-60 %	-0.933 (0.126)
61-100 %	0.133 (0.744)
Proportion of holding sales – direct to final consumer (0%)	
1-30 %	0.850 (0.058)
31-60 %	1.420 (0.061)
61-100 %	0.099 (0.843)
Specialization (arable)	
horticulture	0.384 (0.660)
permanent	-0.051 (0.893)
livestock	‡ **1.171** (0.050)
mixed	-0.146 (0.754)
Utilized Agricultural Area rented in – in hectares	0.004 (0.097)
Direct CAP payments (no)	
yes	-0.095 (0.791)
Previous experience (no)	
yes	‡ **-2.757** (0.001)
Self-chosen measures	-0.354 (0.299)
Better results, higher payment	0.232 (0.528)
Labelled product	0.478 (0.128)
Paid by customers	‡ **0.463** (0.043)
Reduced land rent	0.012 (0.972)
Self-monitoring	-0.150 (0.608)
Control by authority	‡ **0.501** (0.033)
Free training	0.333 (0.329)
Sales guarantee	0.564 (0.151)
Annual compensation	0.140 (0.759)
Periodical payment	0.109 (0.656)

Note: The reference modality of the explanatory variable is in parentheses. * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ in bold indicates the 0.05 level of statistical significance.

Table 7. Model for land tenure contract solution.

Explanatory variable	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
		Easiness of understanding		
Age (18-30)				
31-40	-0.866 (0.080)			
41-50	‡ **-1.019** (0.026)			
51-60	‡ **-0.961** (0.030)			
61-70	‡ **-1.146** (0.024)			
>71	-0.830 (0.156)			
Membership (none)				
farmers union	0.250 (0.316)			
nature conservation/ environmental org.	0.592 (0.133)			
Proportion of holding sales – to private wholesaler/retailer (0%)				
1-30 %	-0.554 (0.125)			
31-60 %	-0.550 (0.229)			
61-100 %	-0.234 (0.518)			
Specialization (arable)				
horticulture	0.944 (0.095)			
permanent	-0.107 (0.725)			
livestock	0.199 (0.634)			
mixed	-0.045 (0.908)			
Organic production (no)				
yes	0.017 (0.952)			
Direct CAP payments (no)				
yes	-0.320 (0.278)			
Previous experience (no)				
yes	‡ **1.750** (0.000)			
Self-chosen measures	‡ **0.606** (0.019)			
Better results, higher payment	-0.307 (0.270)			
Labelled product	-0.248 (0.304)			
Paid by customers	-0.059 (0.772)			
Reduced land rent	0.432 (0.058)			
Self-monitoring	0.152 (0.487)			
Control by authority	0.249 (0.197)			
Free training	0.254 (0.370)			
Sales guarantee	‡ **-0.580** (0.043)			
Annual compensation	0.463 (0.140)			
Periodical payment	0.295 (0.132)			
		Applicability in the farm		
Age (18-30)				
31-40	-0.706 (0.113)			
41-50	-0.683 (0.085)			
51-60	-0.558 (0.136)			
61-70	‡ **-0.964** (0.027)			
>71	‡ **-1.023** (0.041)			
Reduced land rent	0.324 (0.102)			
Control by authority	‡ **0.306** (0.047)			
Annual compensation	0.083 (0.722)			
Periodical payment	0.198 (0.255)			

(Continued)

Table 7. (Continued).

Explanatory variable	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
	Economic benefit			
Age (18-30)				
31-40	-0.616 (0.208)			
41-50	-0.273 (0.539)			
51-60	-0.685 (0.110)			
61-70	-0.730 (0.140)			
>71	-1.015 (0.075)			
Membership (none)				
farmers union	0.165 (0.517)			
nature conservation/ environmental org.	0.394 (0.296)			
Proportion of holding sales – to private wholesaler/retailer (0%)				
1-30 %	0.083 (0.818)			
31-60 %	-0.946 (0.058)			
61-100 %	0.427 (0.286)			
Proportion of holding sales – to cooperatives (0%)				
1-30 %	-0.059 (0.898)			
31-60 %	0.478 (0.355)			
61-100 %	-0.030 (0.925)			
Proportion of holding sales – direct to final consumer (0%)				
1-30 %	0.445 (0.235)			
31-60 %	‡ **1.241** (0.040)			
61-100 %	-0.098 (0.818)			
Specialization (arable)				
horticulture	0.899 (0.102)			
permanent	-0.555 (0.076)			
livestock	-0.320 (0.454)			
mixed	-0.286 (0.467)			
Previous experience (no)				
yes	0.761 (0.071)			
Self-chosen measures	0.993 (0.053)	‡ **-1.031** (0.019)	-0.630 (0.224)	-0.924 (0.105)
Better results, higher payment	-0.133 (0.627)			
Labelled product	0.130 (0.590)			
Paid by customers	0.004 (0.985)			
Reduced land rent	‡ **0.655** (0.004)			
Self-monitoring	0.353 (0.110)			
Control by authority	‡ **0.480** (0.013)			
Free training	-0.095 (0.736)			
Sales guarantee	‡ **-0.625** (0.029)			
Annual compensation	0.370 (0.237)			
Periodical payment	0.010 (0.959)			
	Willingness to enroll			
Age (18-30)				
31-40	-0.816 (0.163)			
41-50	-0.889 (0.095)			
51-60	-0.960 (0.065)			
61-70	‡ **-1.447** (0.012)			
>71	‡ **-1.661** (0.011)			

(Continued)

Table 7. (Continued).

Explanatory variable	VU vs U, N, L, VL*	VU, U vs N, L, VL*	VU, U, N vs L, VL*	VU, U, N, L vs VL*
Membership (none)				
farmers union	0.083 (0.765)			
nature conservation/ environmental org.	0.768 (0.091)			
Proportion of holding sales – to processor (0%)				
1-30 %	‡ **1.208** (0.005)			
31-60 %	0.058 (0.922)			
61-100 %	-0.169 (0.680)			
Proportion of holding sales – to private wholesaler/retailer (0%)				
1-30 %	-0.721 (0.065)			
31-60 %	‡ **-1.051** (0.036)			
61-100 %	-0.187 (0.650)			
Proportion of holding sales – direct to final consumer (0%)				
1-30 %	0.373 (0.349)			
31-60 %	0.930 (0.125)			
61-100 %	-0.880 (0.060)			
Specialization (arable)				
horticulture	0.861 (0.195)			
permanent	-0.394 (0.236)			
livestock	-0.224 (0.625)			
mixed	-0.495 (0.240)			
Direct CAP payments (no)				
yes	0.031 (0.923)			
Previous experience (no)				
yes	0.759 (0.095)			
Self-chosen measures	0.265 (0.347)			
Better results, higher payment	-0.393 (0.195)			
Labelled product	-0.058 (0.829)			
Paid by customers	0.275 (0.203)			
Reduced land rent	‡ **0.848** (0.001)			
Self-monitoring	-0.263 (0.303)			
Control by authority	0.359 (0.091)			
Free training	0.196 (0.516)			
Sales guarantee	-0.373 (0.240)			
Annual compensation	0.407 (0.260)			
Periodical payment	0.325 (0.116)			

Note: The reference modality of the explanatory variable is in parentheses. * VU = Very Unlikely, U = Unlikely, N = Neutral, L = Likely, VL = Very Likely; p-values in parentheses; ‡ in bold indicates the 0.05 level of statistical significance.

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The use of innovative contracts to provide agri-environmental public goods: Comparing attitudes between Ireland and other European countries

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Abstract. Results-based, collective action, value chain, and land tenure contracts are means to improve the management of agri-environmental public goods. The objective of this paper is to assess the understandability, applicability, and perceived economic benefit of each of these contract types by land managers and stakeholders in twelve European countries, with a special emphasis on Ireland. Using survey data, we find that most land managers agree that results-based contracts are understandable, applicable to their farm, and economically beneficial. A lower portion of land managers in Ireland than other European countries agree that value chain and land tenure contracts are understandable or applicable to their farms. The results suggest that greater efforts are required to promote collective action contracts across Europe as they are paramount to the management of public goods. To increase the adoption of innovative contracts, providing financial certainty and autonomy should be prioritized by policymakers, particularly in Ireland.

Keywords: agri-environmental climate public goods, AECPG, results-based contracts, contract design, environmental policy.
JEL codes: H41, O13, Q28, Q58.

1. INTRODUCTION

The provision of agri-environmental-climate public goods (AECPG) such as biodiversity, water and soil quality, and emissions reduction, was very much to the forefront of the European Union's (EU) agenda in the preparation of the latest Common Agricultural Policy (CAP) (European Commission, 2023a). For example, an aim of both the EU's Green Deal and the Farm to Fork initiatives is for food systems to become environmentally sustainable (European Commission, 2023b). Therefore, it is important that land managers are encouraged to sustainably manage AECPG. In line with this purpose, the present paper investigates innovative agri-environmental con-

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tract types. These are contractual arrangements that incentivise farmers to increase the provision of AECPG alongside private goods (Prager et al., 2020) and they are experimental in that they have not been a core feature of traditional agri-environmental schemes (AES) (Bredemeier et al., 2022). The analysis explores the perceptions of agricultural and forestry land managers and other stakeholders (advisers, industry representatives, scientists, researchers, etc.) in terms of the understandability, applicability, and the perceived economic benefits of results-based, collective action, value chain, and land tenure contracts, both in Ireland and in eleven other European countries. Also, we examine the factors that can contribute to the adoption of these innovative agri-environmental contracts.

This paper focuses on the attitudes of Irish land managers and other stakeholders towards innovative contract designs for three reasons. Firstly, agricultural land managers in Ireland play a particularly significant role in the management of AECPG because 72% of land in Ireland is used for agriculture, which is the highest portion of land among EU countries (Eurostat, 2022). As of 2013, 50% of agricultural land in Ireland was under agri-environmental commitments (Eurostat, 2023a). However, regardless of this figure, all land managers influence AECPG such as biodiversity, water quality and carbon sequestration to some degree. Therefore, any efforts to increase the adoption of AES by farmers can help to improve AECPG provision. Secondly, agriculture in Ireland faces considerable environmental challenges as 37% of total greenhouse gas emissions and over 99% of ammonia emissions arise from agriculture due to the large livestock sector (DECC, 2021). Additional worries include concerns over biodiversity loss (Biodiversity Information System, 2022) and unsatisfactory water quality (EPA, 2022), all of which can be managed through effective contract designs. Attitudes towards the four innovative contract designs discussed here have not been previously assessed in the context of Ireland, while a general shortage of debate in relation to the subject exists in the literature (Bredemeier et al., 2022), with studies, such as D'Alberto et al. (2023), focusing on specific territories and case studies. To advance understanding and to improve the design of innovative agri-environmental contracts, the EU has funded several projects under the HORIZON 2020 Programme, such as the CONSOLE project[1] (CONSOLE, 2023) within which the present work was carried out.

[1] The project's full name is **Con**tract **Sol**utions for **E**ffective and Lasting Delivery of Agri-Environmental-Climate Public Goods. Horizon 2020 Grant Agreement number: 817949. More information is available at https://console-project.eu/.

The remainder of this paper provides an overview of AES in Europe, agriculture in Ireland, and current environmental challenges in Section 2. Section 3 describes the data at hand. Section 4 includes an analysis of survey data to determine how understandable, applicable, and economically beneficial land managers perceive various contract types to be. Section 5 contains an assessment of land managers' and stakeholders' recommendations for improving the uptake of AECPG-related contracts.

2. BACKGROUND

2.1 Agri-Environmental Schemes in Europe

Agriculture within the EU is supported by the CAP which consists of two Pillars. Pillar 1 provides financial support to farmers to ensure they have sufficient financial resources to sustain their businesses. This Pillar also provides market measures to help support challenges such as input price volatility, financial crises, and climate change. Pillar 2 is co-financed by Member States and it focuses on rural development. Its aims include, among others, the modernisation of farms, employment support, and generational renewal (European Council of the EU, 2023). Voluntary environmental protection measures have also been traditionally financed by Pillar 2 (Kelemen et al., 2023). From 2023, these policy tools are managed by Member States through their national CAP strategic plans (EU CAP Network, 2023).

AES are financed under Pillar 2 (Kelemen et al., 2023) and they are the primary mechanisms through which land managers are financially rewarded for farming in an environment-friendly manner above that required for the Basic Payment Scheme (Teagasc, 2022). The adoption of these schemes was initially voluntary for European countries (Burton and Schwarz, 2013) and the implementation of AES became compulsory for EU Member States in 1992 under EC Regulation 2078/92 (Cullen et al., 2021). However, their adoption by farmers remains voluntary.

In 2013, 26% of the utilised agricultural area of EU countries was under AES (Eurostat, 2023a). However, the environmental effects of land managers' actions are not measurable from this figure, with several authors questioning the effectiveness of AES on biodiversity and/or other aspects of the environment (see, e.g., Bartolini et al., 2021; Batáry et al., 2015). The reward for the adoption of AES has traditionally been 'action-oriented' payments with remuneration being based on a set of prescribed actions rather than the outcome. This focus has been, in part, due to the requirement for compensation to reimburse land managers for the cost of adopting a particular

agri-environmental practice (Burton and Schwarz, 2013). Burton and Schwarz (2013) provided examples of scenarios where action-based contracts have failed to provide environmental benefits such as the failure of action-oriented approaches to increase hornworts on the Swiss Plateau, as studied by Bisang et al. (2009), and a decline in bird and butterfly numbers in Switzerland, as noted by Roth et al. (2008). However, action-based approaches continue to be the most common in EU AES despite their limited effectiveness (Olivieri et al., 2021). Their high acceptability by farmers is due to low risk, as their payments are not affected by external factors such as the weather. Action-based contracts are also a suitable option when it is difficult to measure the results of an action, including when monitoring and environmental knowledge is not sufficient (Olivieri et al., 2021).

Issues with the management of any contract can arise through asymmetric information with Oliver et al. (2021) noting that it can reduce the provision of public goods through agriculture. This means that one party may have more information than the other(s) and they can use this to their advantage. This asymmetric information can result in contracts being negotiated that might not have been agreed if both parties were fully truthful. Adverse selection may arise where land managers choose to include low quality land into AES because it is less productive in other uses (Quillérou and Fraser, 2010). Cullen et al. (2018) noted that extensive farms have tended to enter action-based schemes because their compliance costs are generally lower than intensive farms. In addition, Butler et al. (2013) suggested, when referring to the work of Butler et al. (2010), that a possible focus of land managers on ease of management rather than ecological benefits can limit the success of action-based schemes. Moral hazard emerges when one party acts differently, such as taking on additional risks, because they do not bear the full consequences of their actions. This can lead to free riding where, for example, land managers who receive rewards for collective action decide to rely on the positive actions of others rather than their own. These phenomena need to be considered when developing new, innovative contract types.

Four innovative contract types assessed by the CONSOLE project are analysed and discussed in this paper (results-based, collective action, value chain and land tenure contracts).

1. As part of a **results-based** contract, farmers are paid based on the results of their actions. For example, if the intention of the contract is to improve water quality, such a contract may award payments based on the results of water testing completed at agreed dates throughout the lifetime of the contract. Uthes and Matzdorf (2013) highlighted that results-based contracts allow farmers to use local knowledge and environmental learning to ameliorate their farm's results and, hence, they are more efficient than action-based contracts. However, as previously noted, unpredictable external factors such as weather may affect the results land managers achieve and this can discourage them from taking up these contracts. Furthermore, it is sometimes difficult to develop and monitor measurable indicators of environmental improvement (Olivieri et al., 2021).
2. **Collective** contracts require land managers to become members of a group which applies jointly for compensation in order to implement environmental or climate activities (CONSOLE, 2023). For example, if the intention is to improve biodiversity, payments may be awarded based on the count of farm birds in an area at specific times within the contract duration. The rewards would be shared amongst the participants in acknowledgement that the results were a collective achievement. Prager (2015) explained that some approaches emphasise collaboration, which means that farmers work together. Other approaches are based on co-ordination, which implies that farmers work towards the same goal, but in isolation (Prager, 2015; Reichenspurner et al., 2023). The Netherlands is the only EU country to introduce collective AES on a national level. If a land manager wishes to participate in such a scheme, he/she must become a member of an agricultural collective, which is responsible for the contracting and the results measuring (Barghusen et al., 2021). Olivieri et al. (2021) noted that collective contracts could particularly benefit AECPG such as water quality, biodiversity, and landscapes, which require coordinated buy-in from all land managers in an area. In addition, Olivieri et al. (2021) argue that these contracts involve a sharing of knowledge and risks, and issues of moral hazard may be low due to land managers wishing to maintain their reputation instead of free riding. However, it can be difficult to determine the optimum group size and costly to manage a large group (Olivieri et al., 2021) with Rodríguez-Entrena et al. (2019) noting that collective participation leads to a higher degree of uncertainty among the farmers. Similarly, Villanueva et al. (2015) suggested that farmers' utility from engagement in collective participation is negatively influenced by the anticipated loss of freedom of their farm management.
3. **Value chain** contracts connect the delivery of AECPG with the production of private goods (CONSOLE,

2023). The cost of these actions may be paid for by the market, mainly through a premium price. For example, if dairy farmers agree to reduce their greenhouse gas emissions to a certain rate, the reduced emissions levels may be advertised on their bottles of milk and the customer pays a higher price for this guarantee. The contract may be between a land manager and a customer, or it may include many actors along the value chain, such as producers, processors, distributors, and consumers. For example, *Neumarkter Lammsbrau* is a German beer producer that engages in value chain contracts with its suppliers of organic raw materials. The agreements are centred around the protection of soil, water, and biodiversity (Bredemeier et al., 2022). Ireland currently has a quality assurance scheme where sustainable products bear the label 'Origin Green'. However, the products that meet the criteria are not charged at a premium price, so the land managers are not reimbursed for their efforts to produce the product sustainably.

4. **Land tenure** contracts mean that a landowner accepts a lower lease payment than for comparable land under usual land tenure agreements, to compensate land managers for their additional efforts to protect the environment (CONSOLE, 2023). For example, a landowner may contractually require the tenant to comply with certain management requirements like reduced use of pesticides. In addition, long-term and secure contracts often lead to land investments, such as, soil conservation and tree planting which provide benefits for nature and human well-being (Bredemeier et al., 2022; Robinson et al., 2018). It is worth noting that Olivieri et al. (2021) described the current literature on value chain and land tenure contracts as 'poor', fostering the need for research on these contract types.

It should be highlighted that AES can consist of contracts that combine design and governance characteristics from more than one contract type (Bredemeier et al., 2022). For example, AES that aim to enhance biodiversity might involve collective action and land tenure contracts.

2.2 Agriculture in Ireland and Environmental Concerns

The importance of the livestock sector to agriculture in Ireland is highlighted by the fact that, in 2020, 93% of farms were specialist livestock farms (Dillon et al., 2022) compared to 22% in all EU countries (Eurostat, 2022). 17% of Irish farms were dairy farms compared to 5% of farms in the EU (Eurostat, 2022). In 2020, the livestock density in Ireland was 1.3 livestock units per hectare compared to an EU average of 0.7 (Eurostat, 2023b). These relatively high livestock numbers generate environmental challenges, as agriculture produced 37% of greenhouse gas emissions in Ireland in 2020 (DECC, 2021). More than 80% of agriculture-related greenhouse gas emissions is directly linked to livestock numbers and the management of the manures they produce, while 12% is attributed to chemical fertilisers and the remaining 8% arises from fuel combustion and carbon dioxide from lime usage (DECC, 2021). In response to these environmental challenges, The Climate Action Plan 2021 commits to a 22-30% reduction in Ireland's agricultural emissions by 2030, based on 2018 figures (DECC, 2021).

Despite these concerns, livestock numbers continue to rise in Ireland with a 0.5% increase in cattle and a 6.4% increase in sheep between 2021 and 2022 alone (CSO, 2023). This continued increase may suggest a hesitancy of land managers to reduce means of production in order to provide AECPG. This is supported by the work of Cullen et al. (2021) which found that a €1,000 increase in farm income leads to the likelihood of the farmer being an AES participant falling by 1-2%.

Additional environmental concerns include water quality, with the Environmental Protection Agency noting that agriculture substantially contributes to its decline (DECC, 2021). Almost one fifth of monitored river water bodies are of 'poor' or 'bad' status and are severely polluted (EPA, 2022). In addition, 85% of habitats in Ireland are classified as being of 'unfavourable status' and 39% are categorised as 'bad' (EPA, 2023). As an EU member, Ireland is subject to the core targets of the Farm to Fork strategy which are a 50% reduction in chemical or hazardous pesticide use, a 50% reduction in nutrient loss, and a 20% decrease in fertiliser use by 2030 (European Commission, 2020).

2.3 Agri-Environmental Projects in Ireland

Irish AES have evolved since the introduction of the Rural Environment Protection Scheme (REPS) in 1994. There were three subsequent iterations up to 2009 (McGurk et al., 2020). Farmers received the highest payments for the first 20 hectares, with different rates of declining payments for additional hectares across various iterations of the scheme (Cullen et al., 2021). This led to farm size strongly influencing farmers' decision to participate (Hynes and Garvey, 2009).

The Agri-Environment Options Scheme (AEOS) replaced REPS in 2010. It differed in that the focus was on improving particular landscapes and habitat types (McGurk et al., 2020; Murphy et al., 2014) and scheme

entry was prioritised for farms with certain features such as land designated as a Special Areas of Conservation[2] or Special Protection Area[3] (Cullen et al., 2021). However, participation was lower than REPS due to low payments (DAFM, 2017; McGurk et al., 2020). The Green Low-Carbon Scheme (GLAS) replaced AEOS in 2015 and it involved the further targeting of funds to achieve greater scheme results (Cullen et al., 2021). GLAS also had a greater focus on measures aimed at reducing carbon emissions from agriculture. Entry into GLAS was by a three-tier system of priority which considered farms' 'Priority Environmental Assets'. The highest tier included farms with Natura 2000 sites, important farmland birds, rare breeds, commonages, and High-Status waterbodies[4]. The second tier included those with Vulnerable Water Areas and those choosing to undertake 'Priority Actions' which were low emission slurry spreading, minimum tillage, catch crops, and wild bird cover. The third tier applied to the remaining farms (Cullen et al., 2021). All of these schemes have been terminated.

A new agri-environmental climate measure called the Agri-Climate Rural Environment Scheme (ACRES) was introduced in Ireland in January 2023. Its objective is to address biodiversity decline mainly in designated regions, while also serving as an income support. This scheme is funded by the Irish Government and the European Agricultural Fund for Rural Development of the EU, under Ireland's CAP Strategic Plan 2023-27 (DAFM, 2022). There are two entry points to the ACRES, with the ACRES General approach being available nationwide and offering a range of measures for individual land managers. The ACRES Co-operation approach, by contrast, is available to land managers in defined high priority geographical areas where land managers receive results-based payments, and a level of co-operation is required amongst participants (DAFM, 2022).

Eco-schemes, funded under Pillar 1, are conceptually similar to the AES of CAP Pillar 2 and may contain the four innovative contract designs discussed in this study. However, land managers are legally entitled to eco-scheme payments, whereas a granting procedure is used to allocate AES payments. Member States are free to choose eco-scheme measures, as long as they respect the legal requirements in Article 31 of the Strategic Plan Regulation[5] (Runge et al., 2022). This means that their design may benefit greatly from national and local knowledge. In Ireland, land managers qualify for eco-scheme payments by undertaking specific agricultural practices on their farms and they have the flexibility to opt in/out of such schemes and/or change the agricultural practices annually (DAFM, 2023).

2.4 Examples of Recent Voluntary AES in Ireland

Aside from AES that have been directly designed and funded by the Irish Government or the EU and eco-schemes, some locally run agri-environmental projects have provided environmental benefits in recent years and, in many cases, they have included innovative contract designs. The Burren Programme, funded by the Irish Government, seeks to protect biodiversity in the Burren in West Ireland, which is an UNESCO Geopark area of exposed limestone. Participating land managers may enrol in results-based contracts and five-year environmental targets are agreed between land managers and farm advisors. Payments are dependent on land managers implementing plans and performing according to an evidence-based scoring system. The benefits of this project are attributed to the fact that it is locally led, that there are high levels of local engagement and that farms' assessment is based on scientific evidence (CONSOLE, 2022a).

The Biodiversity Regeneration in a Dairying Environment (BRIDE) Project, funded by the EU Commission and the Irish Government, also uses results-based contracts and land managers agree to improve the quality of the habitats on their farms. Similar to the Burren Programme, farms are assessed and those with higher scores on habitat quality gain higher payments. The project has benefitted from strong engagement from local land managers showing that the introduction of biodiversity measures contributes to tangible environmental, economic, and social benefits (CONSOLE, 2022b).

The Results-based Agri-Environment Payment Scheme (RBAPS) Pilot in Ireland, funded by the EU Commission and the Irish Government, aimed to

[2] The EU Habitats Directive lists certain habitats and species that must be protected within Special Areas of Conservation. 'Irish habitats include raised bogs, blanket bogs, turloughs, sand dunes, machair (flat sandy plains on the north and west coasts), heaths, lakes, rivers, woodlands, estuaries and sea inlets' (National Parks and Wildlife Service, 2023).

[3] Sites of importance for the conservation or protection of a natural habitat or the population of a species.

[4] Coastal, transitional, river and lake water bodies that have a High-Status Objective under the EU Water Framework Directive (Environmental Protection Agency, 2020).

[5] This Article establishes that all EU Member States must define and provide support for voluntary schemes for the climate, the environment and animal welfare (the 'eco-schemes') under the certain conditions that are set out in this Article and as further specified in the CAP. Participants are active farmers or groups of active farmers who make commitments to observe agricultural practices beneficial for the climate, the environment, animal welfare and combatting antimicrobial resistance. Further information is available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R2115 .

improve biodiversity on 35 farms in an area of High Nature Value farmland by using results-based payments. Small scale, low intensity beef cattle, and sheep farming were targeted (CONSOLE, 2022c). RBAPS was similar to the Burren and BRIDE Projects in that it focused on improving biodiversity in a small area, which means that collective action is also at play within each project.

The Carbery Greener Dairy Farms scheme is also results-driven. However, the reward for farmers are the savings they make rather than the receipt of payments. The project was introduced by Carbery Group[6] and Teagasc[7] to measure, monitor, and optimise resources allocation with regard to environmental sustainability on dairy farms. The programme was based on a previous European project called the Dairyman Project, where 120 dairy land managers in 10 regions of Northwest Europe focused on farm resources efficiencies and management (CONSOLE, 2022d). Carbery was the first to start such an endeavour in Ireland. Various environmental efficiency measures were introduced on each farm to improve performance and achieve financial savings. The benefits from this project are improved carbon footprint of the farms, viability of farms through greater efficiencies, higher quality products, and an evolving ecological mind-set of land managers which spills-over into the wider community (CONSOLE, 2022d). To improve environmental efficiencies, various capital expenditure was required, such as the introduction of smart meters, plate coolers in milking parlours, and water storage tanks. The funding was provided by Carbery, State grants and, in some instances, the land managers themselves (CONSOLE, 2022d). This is an example of land managers, industry, and the State working together to achieve environmental objectives.

2.5 Factors Influencing the Perceived Benefits of Innovative Agri-Environmental Contracts in Ireland

In the literature, the understanding, applicability, and perceived economic benefits of AES by land managers have been shown to influence their adoption. For example, Wilson and Hart (2000) found that non-familiarity with AES can increase the likelihood of farmers being unable to agree with their benefits. To overcome this, Morris et al. (2000) argued that while mass media and generic literature are useful for increasing the understanding of AES, personal contact and demonstration are more important for the adoption of environmental measures. Similarly, Defrancesco et al. (2008) and Dessart et al., (2019) found that the more a farmer perceives he/she can easily implement a practice associated with a given agri-environmental contract, the more likely he/she will participate in it. It is indeed crucial that land managers understand AES and the possible contracts that may exist within each scheme, so that they can perceive them as being applicable and beneficial to their land.

Cullen et al. (2020) studied AES adoption in Ireland and they discussed a potential link between understanding and perceived economic benefits. For example, farmers who self-identify as 'Productivists'[8] are more likely to participate in AES if there is a potential increase in the profitability of their farm. While monetary incentives already exist in AES, Cullen et al. (2020) note that it is important that the added economic benefits of environmental measures are demonstrated to land managers to encourage their adoption. These measures may include optimising nutrient application, increasing pollinator numbers, and improved slurry management. Promotion of these measures may also increase the participation of 'Forward-Looking Farmers' who are seeking means to enhance the long-term performance of their farms. Cullen et al. (2018) also note that the involvement of farmers in the designing of AES will help to ensure that they suit land managers' interests and practices.

Kelemen et al. (2023) studied the same four innovative contracts as those outlined in our study. They asked stakeholders in fifteen countries to compare the innovative contract types with existing mainstream action-based AES and they found that results-based contracts are perceived to require a 'a broader knowledge base and a more developed infrastructure' than mainstream AES and the other three innovative contract types. This further highlights the need for land managers to understand the nuances of contract types to increase their adoption.

The findings of Kelemen et al. (2023) question the applicability of collective contracts as they are considered to be the least suited to existing institutions, and the social and cultural context. One stated reason was the opinion that farmers only collaborate when there is a business interest and that collective contracts might require additional coordination and management. The authors also stress concerns over the perceived economic benefits of results-based contracts. They found that European stakeholders perceive results-based contracts

[6] A global leader in food ingredients, flavours, and cheese. More information on this organisation is available at https://www.carbery.com/.

[7] A State body which provides research, advisory, and training to the agricultural and food sector in Ireland. More information on this organisation is available at https://www.teagasc.ie/.

[8] Cullen et al. (2020) use the term 'Productivists' to describe farmers who express a desire to produce more food and maximise income, even if the environment is harmed in the process.

to be 'more costly to implement' than mainstream AES and the three other innovative contract types. However, they do not study this on a per country basis.

In the study by Kelemen et al. (2023), the preferred policies stated by the stakeholders to improve the adoption of the four innovative contract types were formal education, peer-to-peer learning, and financial top-ups. Education and learning would help understanding, while the top-ups would help to reduce financial uncertainty. The provision of top-ups allows farmers to retain their flat payment and lose only the top-up if environmental targets are not met (Kelemen et al., 2023).

3. DATA AND METHODOLOGY

3.1 Overview of data collection

Data were collected as part of the EU Horizon 2020 funded CONSOLE Project (*Contract Solutions for Effective and lasting delivery of agri-environmental-climate public goods*). Surveys were conducted in twelve European countries (Austria, Bulgaria, Finland, France, Germany, Ireland, Italy, Latvia, Poland, Spain, Netherlands, and the United Kingdom), with 2,275 land managers and 486 stakeholders surveyed between December 2020 and July 2021 based on non-probability sampling. The Irish sample of respondents includes 210 land managers and 16 stakeholders (farm advisors, researchers, and industry experts). The survey questionnaires were designed by means of a common approach by the project partners, in English, and they were then translated to national languages (D'Alberto et al., 2022). The questionnaires were disseminated by project partners directly, as well as by non-profit organizations, farmers unions, and local institution boards. The non-probability sampling is due to the fact that the questionnaires, conducted during the COVID-19 pandemic restriction period, were distributed mainly via the CONSOLE Project's website, through local institutions' mailing lists, and local institutions' official social media accounts. Therefore, respondents were self-selected.

3.2 Land manager surveys

In Ireland, the land manager surveys were distributed by an agency which provides administrative and technical advice to farmers and all surveys were completed online. The characteristics of the Irish sample are outlined in Table 1, as well as those of all twelve European countries studied. The data of the survey respondents can be compared to nationally representative data which is derived from the Farm Accountancy Data Network (FADN, 2021) and Eurostat data[9] (Eurostat, 2016; Eurostat, 2021a, Eurostat, 2021b)[10]. Farm Accountancy Data Network (2021) data on farm types and data collected by Eurostat (2021) on formal agricultural training can be directly compared with the sample of this study. However, Eurostat (2021) collected data on farm holders' ages under categories that differ from those used in our survey. We use data collected by Eurostat (2016) on farm holders who describe their main economic activity as being derived from their farm as a proxy variable for farm income being more than 50% of total income.

Table 2 includes descriptive statistics related to the surveyed land managers' experiences and opinions of innovative agri-environmental contract designs. As noted in Table 2, 30% of surveyed land managers in Ireland are currently using results-based contracts, 17% are using collective action, 16% are using value chain, and 3% are using land tenure contracts. Between 1 and 5 years is the most preferred contract duration. To the best of the authors' knowledge, data on the current use of innovative agri-environmental contracts are not currently collected on a level that is representative of the European Union or its Member States.

Respondents were asked to select a scoring option on a 5 points Likert scale, expressing whether a characteristic of a potential agri-environmental contract would increase their willingness to enrol in such contracts. The options were: *increases willingness considerably*, *somewhat increases willingness*, *no effect*, *somewhat decreases willingness* and *decreases willingness considerably*. These characteristics of potential contracts are listed in Table 3.

Then, descriptions of results-based, collective action, value chain, and land tenure contracts (as described in Section 2.1) were provided to participants. They were asked whether they *strongly agree, agree, are neutral, disagree* or *strongly disagree* with the following statements: 1) 'The contract type is easy to understand'; 2) 'The contract type is applicable to my farm', 3) 'The contract type is economically beneficial for my farm'.

3.3 Stakeholder survey

Each project partner selected local stakeholders to complete surveys and attend workshops at a local level.

[9] Data on farm holders' ages and formal agricultural training in the United Kingdom are not reported by Eurostat and, therefore, are not included in Table 1.

[10] This datasets do not include forests.

Table 1. Descriptive statistics of surveyed land managers.

Variable	Frequency			
	Ireland		All surveyed countries	
	Sample (n=210)	Nationally representative data	Sample (n=2,721[1])	Representative data
Farm type				
Dairy	0.55	0.17	0.14	0.11
Cereals	0.01	0.03	0.21	0.19
Field crops/Permanent crops	-	-	0.13	0.16
Mixed systems	0.01	0.02	0.11	0.10
Cattle	0.21	0.60	0.08	0.10
Sheep/Goats/Poultry	-	0.17	0.03	0.08
Mixed livestock	0.21	0.01	0.02	0.01
Forestry	0.01	-	0.16	-
Fruit/Vineyards/Horticulture	-	-	0.10	0.25
Other	-	-	0.02	-
Agriculture/Forestry Education				
Completed	0.82	0.54	0.60	0.65
Age				
18-30 Years	0.06	-	0.07	-
31-50 Years	0.53	-	0.42	-
51-70 Years	0.39	-	0.44	-
71 Years and older	0.02	-	0.07	-
< 25 Years	-	0.01	-	0.01
25-29 Years	-	0.08	-	0.08
30-34 Years		0.07		0.08
35-44 Years	-	0.10	-	0.11
45-54 Years	-	0.27	-	0.30
55-64 Years	-	0.24	-	0.29
65 Years and older	-	0.23	-	0.13
Farm To Total Income Ratio				
Farm income > 50% Total income	0.66	0.52	0.88	0.75

[1] 2,721 valid land manager surveys were considered from the 2,275 units initially retrieved.

Of the total sample, 61% of participants were scientists, 19% represented environmental NGOs or advisory services, 10% worked in administration, 7% were farmers, foresters or landowners, and 3% worked in industry. The aim of the workshops was to discuss and select the most promising examples of existing contract solutions among those retrieved by the common literature review. The reasons for the failure or success of these contracts were identified and discussed too. In October 2020, a pan-European web-seminar with 105 participants (excluding the organisers and panellists) was held online (for further details, please refer to Viaggi et al., 2020). Stakeholders from the local level workshops were called to discuss, together, the results from each country. In addition, stakeholders were asked whether they *strongly agree, agree,* are *neutral, disagree* or *strongly disagree* with the statement that the features of contracts outlined in Table 4 would increase the willingness of land managers to enrol in an agri-environmental contract.

In addition, stakeholders were asked the following question: *'In your opinion, for which environmental objective provision would the four contract types be the most suitable? Choose only one environmental objective for each contract type.*' The options were landscape and scenery: biodiversity, soil health and quality, carbon storage, and water quality and quantity.

Table 2. Descriptive statistics of surveyed land managers' experiences.

Variable	Frequency	
	Ireland (n=210)	All Surveyed Countries (n=2,721)
Experience of results-based contracts		
Currently using results-based contract	0.30	0.21
Never used results-based contract	0.66	0.73
Previously used results-based contract	0.04	0.06
Experience of collective action contracts		
Currently using collective contract	0.17	0.06
Never used collective contract	0.81	0.91
Previously used collective contract	0.02	0.03
Experience of value chain contracts		
Currently using value chain contract	0.16	0.16
Never used value chain contract	0.82	0.81
Previously used value chain contract	0.02	0.03
Experience of tenure based contracts		
Currently using tenure contract	0.03	0.07
Never used tenure contract	0.96	0.90
Previously used tenure contract	0.01	0.03
Preferred contract length[1]		
< 1 Year	0.05	0.23
Between 1 and 5 Years	0.72	0.66
> 5 up to 10 Years	0.23	0.11

[1] Respondents answered this question regardless of whether they have used entered a contract before or not.

Table 3. Contract Characteristics Evaluated by Land Managers.

Contract characteristic	Definition
Self-chosen measures	In the contract, the land manager is free to decide about the management practices used to achieve the specified environmental result.
Common payment	A group of land managers receive a common payment and they jointly agree on the distribution of the payment.
Paid by customers	The contract is not paid by public money, instead the compensation that a land manager gets for environmentally friendly production is paid by buyers of products.
Reduced rent	Land managers pay reduced rent on land rented in if they agree to follow environmental management clauses as specified in the lease contract.

4. RESULTS AND DISCUSSION

4.1 Land managers' attitudes to innovative contract designs

Figures 1 details the percentage of land managers who agreed that a characteristic of a contract would increase their willingness to enrol in a hypothetical agri-environmental contract/programme. The data for Ireland is labelled 'IRL' and the data for the other eleven European countries is noted as 'Others.'

Figure 1 suggests that self-chosen measures increase the willingness of most surveyed land managers to enrol in novel AES in Ireland and other European countries. This supports the work of the EU in ensuring that each Member State develops its own national CAP Strategic Plan in consultation with land managers and other stakeholders. More specifically, it is important that land managers have autonomy over how they manage their land to achieve environmental benefits and the design of AES should allow for this. When the means of the responses[11] are calculated for each contract characteristic, the results for Ireland and the other countries are very similar.

It is important to highlight that common payments are not desired by many respondents in all countries, which plays as a major obstacle for the implementation of collective contracts. A reluctance to share a common payment may be due to increased uncertainty (Rodríguez-Entrena et al., 2019) or a fear that they will lose autonomy by working collectively (Villanueva et al., 2015). They may also fear that others will act as free riders, benefitting from the group's actions without contributing themselves, which would contradict the perception of Olivieri et al. (2021) that the desire of group members to maintain their reputation would reduce the risk of moral hazard. Our finding supports the work of Kelemen et al. (2023) which noted that collective arrangements are not considered to be the suited to existing institutions, and the social and cultural contexts.

As previously mentioned, descriptions of results-based, collective action, value chain, and land tenure contracts were then provided to participants who were asked to rate their level of agreement with the understandability, applicability, and economic benefits of these contracts. Figure 2 details the percentage of surveyed land managers who agreed that a contract type is easy to understand/applicable/economically beneficial.

Figure 2 shows that results-based contracts are considered understandable, applicable, and economically beneficial by more land managers in Ireland than other European countries. Of the four innovative contract

[11] Based on the points of the Likert scale ranging from 1 (decreases willingness considerably) to 5 (increases willingness considerably).

Table 4. Contract characteristics evaluated by stakeholders.

Contract characteristic	Definition
Annual compensation	Land managers receive compensation payment on an annual basis.
Authority control	The results that land managers achieve are regularly controlled by the competent authority visiting a farm e.g. once a year.
Self-chosen measures	In the contract, the land manager is free to decide about the management practices used to achieve the specified environmental result.
Better results, higher payment	The better the environmental result, the higher the payment.
Collective agreement	Land managers can collectively agree on environmental targets and measures at landscape-level together with other land managers.
Common payment	A group of land managers receive a common payment and they jointly agree on the distribution of the payment.
Free training	Land managers are offered free training and advice that enables them to reach the environmental targets.
Labelled product	Land managers sell their products labelled as environmentally friendly (e.g. climate friendly products) when following management measures as prescribed in a processor or retailer contract.
Paid by customers	The contract is not paid by public money, instead the compensation that a land manager gets for environmentally friendly production is paid by buyers of products.
Reduced rent	Land managers pay reduced rent on land rented if they agree to follow environmental management clauses as specified in the lease contract.
Sales guarantee	Land managers receive a sales guarantee from a processor or retailer in return for implementing environmental measures.
Self-monitoring	Land managers do the monitoring of the environmental results themselves (e.g. count specific plants).
Periodical payment	Land managers receive half of the environmental payment at the beginning of the five-year contract period, and half at the end of it.

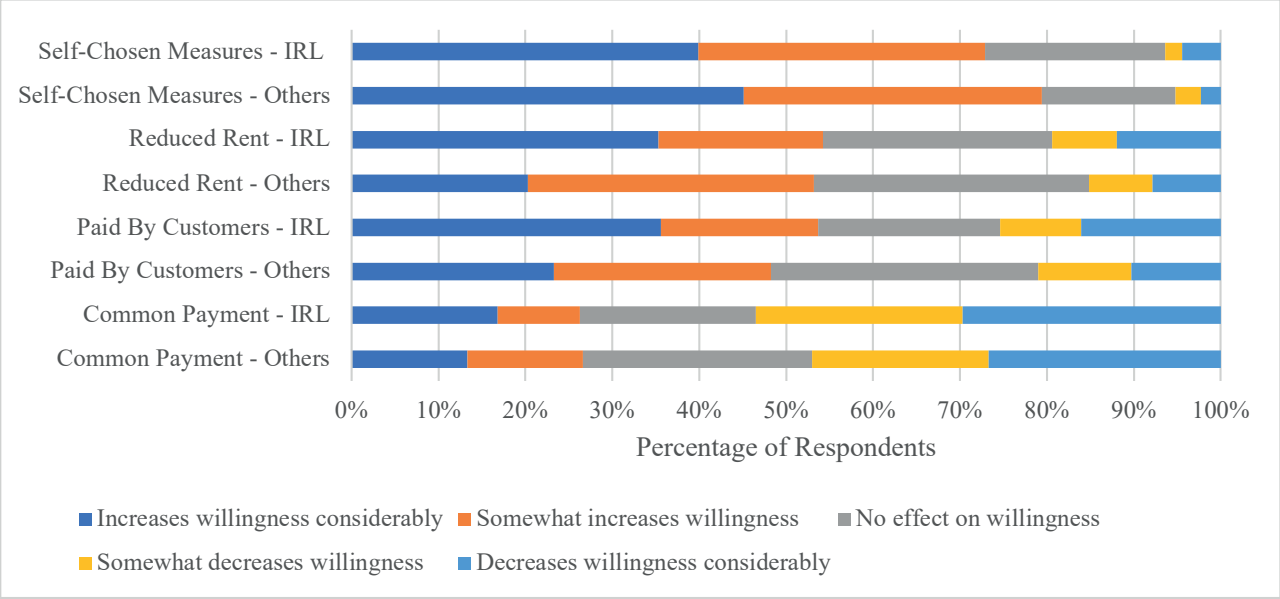

Figure 1. The impact of contract characteristics on willingness to enrol in agri-environmental contracts.

types, the understandability of results-based contracts in Ireland scores the highest, at a mean of 4.0[12], while the mean score of this characteristic for all other countries is 3.8. In relation to results-based contracts, the greatest difference in means between Ireland and the other European countries is related to the applicability of results-based contracts. The mean score in Ireland is 4.1 compared to

[12] Based on the points of the Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

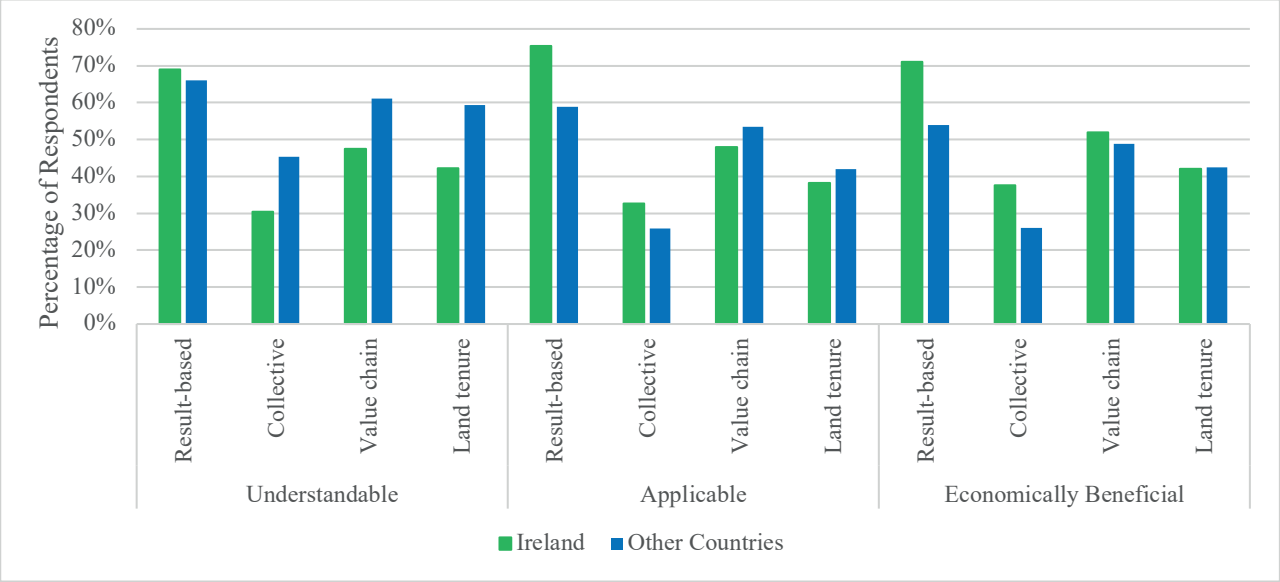

Figure 2. The percentage of land managers who (strongly) agree that a contract type is easy to understand/applicable/economically beneficial.

3.6 in other countries. This finding is plausible considering that they are the most common of the four contract types in the sample for Ireland. They are also perceived by many to be economically beneficial which follows the connection between familiarity and perceived benefits previously highlighted by Wilson and Hart (2000). Given their relative popularity in Ireland[13], it is possible that some farmers with no first-hand experience of results-based contracts may have gained some insights from those who have personal experience of them.

Compared to other European countries, agreement with the understandability and applicability of value-chain and land tenure contract types in Ireland is relatively low. This is an important finding because, as previously noted, the more a farmer perceives that he/she can easily implement an element of a given agri-environmental contract, the more likely he/she will participate in it (Defrancesco et al., 2008; Dessart et al., 2019). Therefore, our findings call for greater education of these contracts in Ireland to increase their adoption. Approximately one half of surveyed Irish land managers consider value chain contracts to be economically beneficial and, despite their rarity, this suggests there is some interest amongst land managers in Ireland to enter this type of contract.

As land rental levels in Ireland are the second lowest in Europe, after Portugal, (European Commission, 2022), it may be difficult for some Irish land managers to imagine that a land tenure contract would be suitable for them. Land is also typically rented on eleven-month contract agreements in Ireland and the Irish Government is already encouraging the renting out of land on long term leases through tax incentives (Bradfield et al., 2023a). Longer contract durations may encourage landowners to include environmental management conditions in their contracts, as the added time may allow them to reap greater benefits from the tenants' practices.

Collective contracts are considered to be understandable, applicable, and economically beneficial by the lowest percent of Irish and other European land managers. A lack of understanding may be driving the other two factors to be low. It may also be the case that land managers enjoy the autonomy of managing their own farm and do not wish to be contractually linked to other land managers which is supported by respondents being in favour of self-chosen measures (Figure 1). Previous work by Raina et al. (2021) also supports this conclusion as they noted that some studies have found that farmers prefer individual management and discrete compensation. Another example is offered by Rodríguez-Entrena et al. (2019) who stated that collective participation leads to a higher degree of uncertainty among the farmers. Farming already bears considerable risk, whether it be financial risk, unpredictable weather or susceptibility to international economic shocks. Consequently, land managers may be reluctant to bear more uncertainty through collaborative work (Rodríguez-Entrena et al., 2019).

In summary, of the four innovative contract types presented in this paper, results-based are considered to

[13] 34% of Irish farmers in this sample have experience of using these contracts compared to 27% in all twelve surveyed countries.

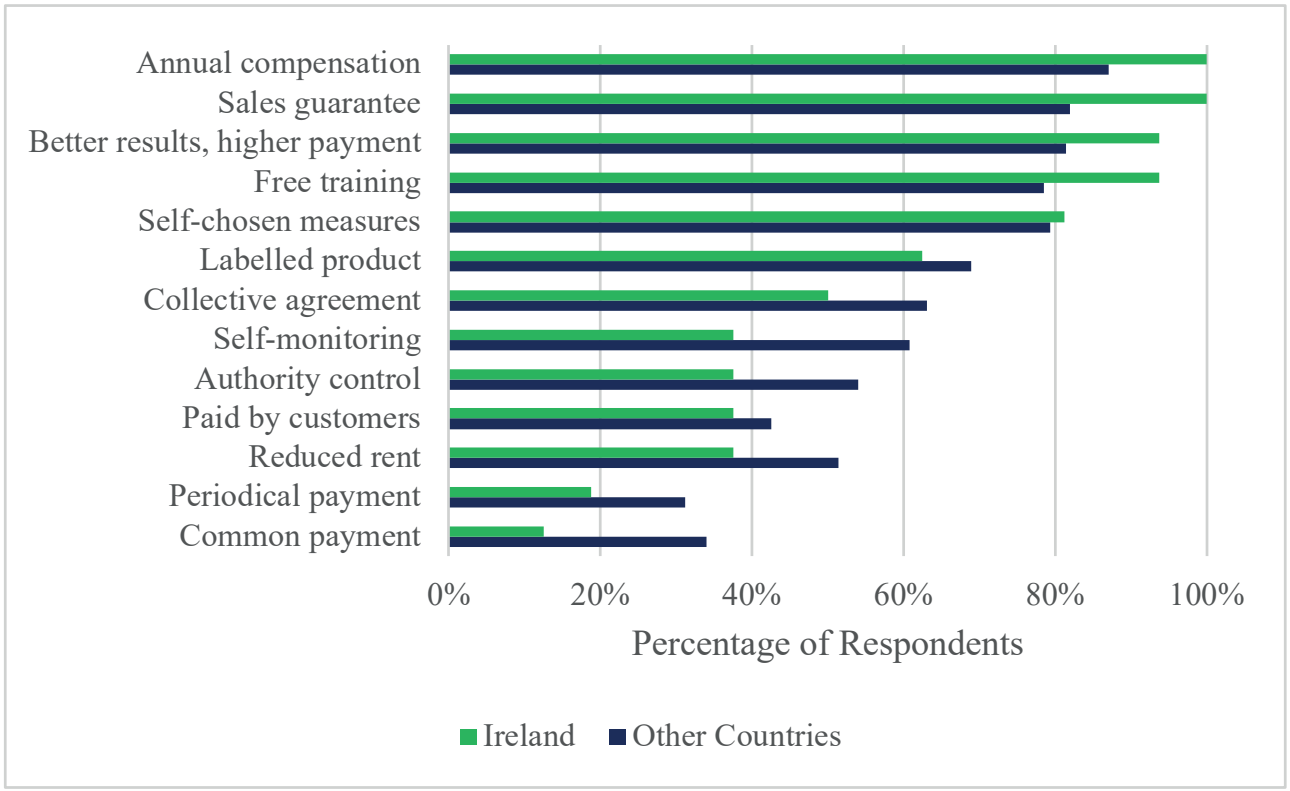

Figure 3. The percentage of stakeholders who agree that a characteristic increases land managers' willingness to enrol in an environmental contract/programme.

be understandable, applicable, and economically beneficial by approximately 70% of surveyed land managers in Ireland which is higher than in other European countries. This high percentage may be driven by the existing familiarity with this contract type and the fact that they allow for autonomy over both work and its potential results. Compared to data from other European countries, the understanding of value chain, collective action and land tenure-based contracts is low in Ireland, and further research may explore the reasons why this is the case.

4.2 Stakeholders' attitudes to innovative contract designs

A previously mentioned, stakeholders were asked whether they agree that a characteristic increases land managers' willingness to enrol in an environmental contract/programme and their responses to this question are presented in Figure 3.

'Annual compensation' and 'sales guarantee', which both provide financial certainty, were considered by most stakeholders to be particularly important to land managers in both Ireland and across Europe. A reward system of better results generating higher payments ('better results, higher payment') also scored highly. This is also a contract characteristic that supports the desire for financial certainty, as well as environmental benefits. Free training is also considered to be important for the uptake of such contracts. When compared to other European countries, land managers in Ireland tend to be less in favour of collective action or authority control. This supports our conclusion in Section 4.1 that there is a strong desire for autonomy amongst land managers. This may be related to the memory of the fight for independence in the early 1900s to remove authoritative control from English landlords (Bradfield et al., 2023b).

In Ireland, a lower percentage of respondents perceive that the self-monitoring of environmental results encourages enrolment, when compared to other European countries. It may be the case that authority control is thought to be undesirable by land managers in Ireland, because it reduces autonomy over land management practices, but the monitoring of environmental outcomes by external agencies is accepted. Keleman et al. (2023) highlight that the monitoring of results poses a challenge for innovative contracts with the definition of indicators, use of information technology and farmers'

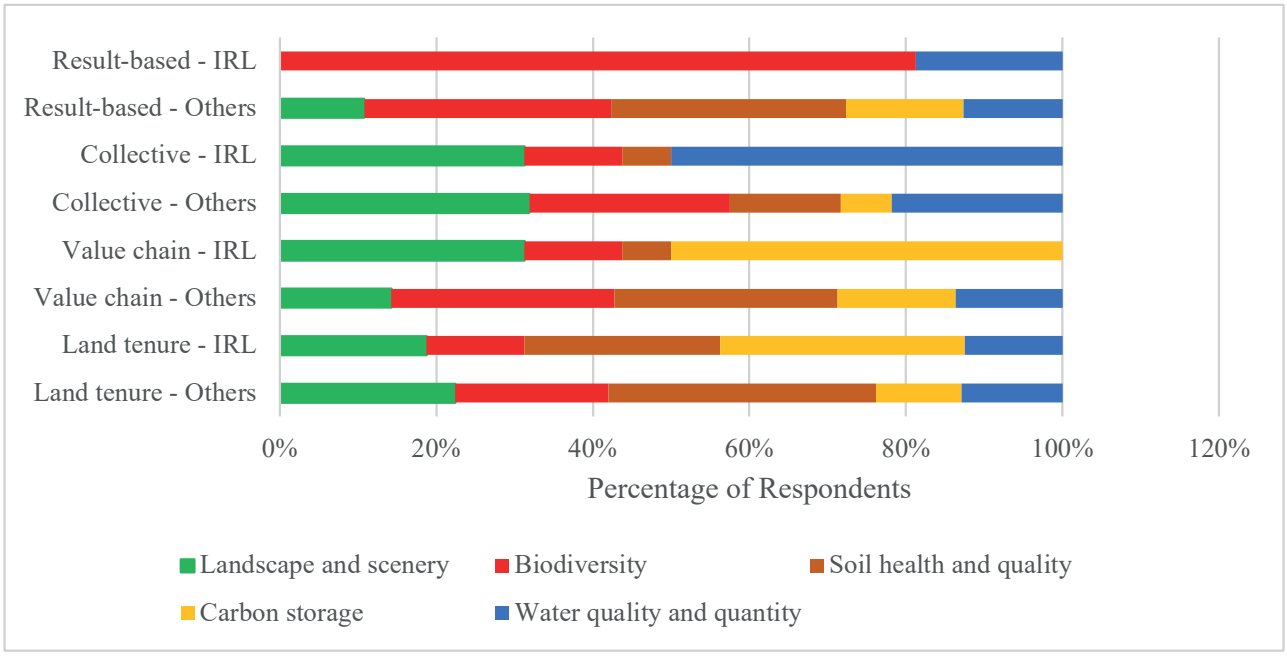

Figure 4. Perceived suitability of contract type for environmental objective (Ireland). Also available in D'Alberto et al. (2022).

expertise being some examples. These may be reasons why farmers are hesitate to self-monitor their actions. All countries perceive periodical payments[14] or common payments to be the least likely to increase enrolment which further supports a desire for control over incomes.

As the aim of AES and agri-environmental contracts is to improve environmental outcomes, we wish to discover which agri-environmental goods are considered to benefit most from a particular contract type. Therefore, stakeholders were asked the following question: *'In your opinion, for which environmental objective provision would the four contract types be the most suitable? Choose only one environmental objective for each contract type.'*

Figure 4 displays the percentage of respondents who stated that a particular agri-environmental objective would benefit the most from a specific contract type. Data for Ireland is labelled 'IRL' and the data for the other eleven European countries is noted as 'Others'.

In Ireland, most surveyed stakeholders believe that biodiversity would benefit the most from results-based contracts. As previously shown in the description of AES case studies, results-based contracts in Ireland have so far mainly targeted improved biodiversity, which may explain why stakeholders in Ireland see a link between these contracts and biodiversity gains. We find that collective action is perceived as the most beneficial for improving water quality amongst respondents in Ireland. However, it is the innovative contract type that scores the lowest in terms of understandability, applicability, and perceived economic benefit, and further education may be needed to highlight its potential environmental benefits. A high portion of surveyed stakeholders in Ireland feel that value chain contracts are best suited to support carbon storage. Fewer of the surveyed stakeholders in other European countries believe that individual contract types can benefit one particular AECPG. This suggests that they perceive the contracts as having a wider range of environmental benefits which is appropriate given that, for example, collective contracts can benefit AECPG such as water quality, biodiversity, and landscapes across large regions (Prager, 2015; Olivieri et al., 2021).

A limitation of this study is a lack of representativeness of the farming population, given the fact that the survey has been carried out on a non-probability sample. However, the large spectrum of respondents questioned, both in Ireland and at the European level, support the conclusion that our results remain informative, and the common European survey perspective adds relevance to the comparisons made. Further research could include analysis of the factors that cause land managers and stakeholders to either agree or disagree that a contract

[14] Stated as follows: 'Land managers receive half of the environmental payment at the beginning of the five-year contract period and half at the end of the contract'.

type is understandable, applicable, and economically beneficial. Additionally, more complex experimental research, such as discrete choice experiments, could be utilized to determine the extent to which land managers prefer some characteristics of agri-environmental contracts over others.

5. CONCLUSIONS

Understanding the factors influencing farmer decision-making is important for policymakers in their design and promotion of agri-environmental schemes. Existing evidence suggests that action-based contracts have not maximized environmental benefits (Burton and Schwarz, 2013) and, as an alternative, four innovative contract types have been studied by the EU funded CONSOLE Project. This research highlights the perceptions of land managers and stakeholders in terms of the understandability, applicability, perceived economic benefits, and characteristics of such contract forms, which have not been previously studied in the context of Ireland despite the challenges the agriculture sector faces in becoming more environmentally sustainable. This research fills a gap in the literature as discussion of these contracts has been limited to date (Bredemeier et al., 2022) and it is important that we understand how attitudes differ in Ireland compared to other European countries so that further research and the CAP can be tailored to fit the local context.

Our findings show that the understanding of the four innovative contract types, as well as their applicability and economic benefits, could be greatly improved in European countries. This calls for greater promotion and education of these contracts to encourage their adoption. Results-based contracts, which are the most common of the four innovative contract types in Ireland, are considered understandable, applicable, and economically beneficial by the majority of Irish land managers. This suggests that practical experience or the hearing of other people's experiences can boost understanding and this form of promotion should be encouraged. This is important for land managers in Ireland who have relatively low levels of understanding of collective action, value chain, and land tenure contracts due to the fact that they may have had little direct experience of them.

With respect to the need for increasing the adoption rate of agri-environmental contracts, self-chosen measures and financial certainty should be the priority, as advised by land managers and stakeholders across Europe, and this is particularly the case in Ireland. Therefore, it is of importance that agri-environmental policies in Ireland provide autonomy for farmers. These findings also help to explain why collective contracts are not considered to be economically beneficial by many land managers in this study, as they potentially expose land managers to uncertainty (Rodríguez-Entrena et al., 2019). Training and guidance from expert stakeholders are also considered important for the uptake of such contracts, supporting our conclusion that education about innovative contracts is fundamental.

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